STATE OF CALIFORNIA
The Resources Agency

Department of Water Resources

BULLETIN No. 137

SACRAMENTO VALLEY EAST SIDE INVESTIGATION

A Study of Surface Water Development Opportunities in Eastern Tehama and Western Butte Counties

Preliminary Edition

AUGUST 1967

RONALD REAGAN
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FOREWORD

This bulletin presents the results of a 5-year water resources study of the streams tributary to the Sacramento River from the east, between Battle Creek and the Sutter Buttes.

The investigation was proposed by the Department of Water Resources under the California Water Development Program. The Legislature concurred in this selection by the inclusion of $45,000 in the 1961-62 Budget to begin the study. The total cost of the investigation was $510,000.

The objective of the study was to formulate plans for the development of water supplies for all beneficial uses within the area. It was concluded that, through multiple-purpose use of the waters of east side streams, several projects can be developed for future construction. The most promising projects are (1) the Mill-Deer Project centered about a proposed Deer Creek Meadows Reservoir on upper Deer Creek; (2) the Wing Project on Inks Creek; (3) the Jonesville Project on upper Butte Creek; and (4) the Belle Mill Project on Salt, Little Salt, Millrace, and Antelope Creeks. These projects should be the initial developments toward full utilization of the water resources of the Sacramento Valley east side area. This report includes specific recommendations for implementation of these plans.

William R. Gianelli

William R. Gianelli, Director
Department of Water Resources
The Resources Agency
State of California
June 14, 1967

State of California
The Resources Agency

DEPARTMENT OF WATER RESOURCES

RONALD REAGAN, Governor
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ABSTRACT

The study area comprises 2,000 square miles of valley and mountainous lands east of the Sacramento River between the Sutter Buttes and Mt. Lassen. The 5-year investigation, which began in July 1961, was made because of the growing (1) statewide need for new water supplies, (2) demand for water-oriented recreation, and (3) emphasis on preservation and enhancement of salmon and steelhead habitat. / The mean annual runoff of 1.2-million acre-feet is almost completely uncontrolled because existing reservoirs provide only a few thousand acre-feet of storage. Water problems include: (1) Inadequate water supplies restrict residential development of plateau lands. (2) Irrigation diversions on the valley floor take almost all the summer and fall flows from streams. (3) Increased diversions from east side streams reduce populations of andromodous fish. (4) Spring and winter floods cause damage to agricultural lands along streams. / Streams include Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks, along with several small tributaries. Of the projects evaluated, four are considered the most promising: Mill-Deer, Wing, Jonesville, and Belle Mill. / Four appendixes provide a Bibliography, a report by the Department of Parks and Recreation, a report by the Department of Fish and Game, and an acknowledgment of assistance received during this investigation.

CHAPTER 1. SUMMARY

This bulletin reports on water resources studies conducted for the Sacramento Valley east side area, 2,000 square miles of land lying east of the Sacramento River and extending from the Feather River north to Mt. Lassen and Red Bluff. This investigation, which ran from July 1961 through June 1966, was made because of the rapidly growing need for development of new water supplies in the area, the growing demand for water-oriented recreation, and the growing emphasis on preservation and enhancement of salmon and steelhead. Results of the investigation indicate that, through multiple-purpose use of the waters of east side streams, projects can be developed for construction in the near future.

In addition to this report, several appendixes and office reports have been prepared to supplement and support the information presented here. Appendixes, under this cover, include: Appendix A, Bibliography; Appendix B, Recreation; Appendix C, Fish and Wildlife; and Appendix D, Acknowledgement. Office reports, which are on file with the Department's Northern District, present: Hydrology, Geology, and Designs and Cost Estimates.

Objective and Scope of Investigation

The objective of the Sacramento Valley East Side Investigation was to formulate plans for the development of water supplies for all beneficial uses within the area. Inventories were made of the water resources and the water requirements of the area. Based upon the data developed during these inventories, general plans of physical works were formulated in accordance with basin-wide multiple-purpose planning concepts. Consideration was given to water conservation, flood control, hydroelectric power, recreation, and fish and wildlife enhancement. Water conservation projects which appear to have possibilities for development in the near future were analyzed with respect to engineering feasibility and economic justification.

Water Problems in the East Side Area

Lack of adequate water supplies has hindered suburban and rural residential development in prime mountainous plateau lands. Where water is available, such as at the community of Paradise, extensive development has occurred. The ridge lands north of Paradise along the east side of Butte Creek, the Forest Ranch Ridge between Butte and Big Chico Creeks, and the Cohasset Ridge west of Big Chico Creek are areas where development can be expected if water is made available. The need for water for summer homes in the Deer Creek Meadows area conflicts with water needs of downstream irrigators on the valley floor. These irrigators have water rights to virtually all of the flow of Deer Creek during the summer months.

Irrigation diversions on the valley floor take nearly all of the summer and early fall flows from the major streams in the east side area. Ground water pumping has developed in recent years to supplement these diversions and this trend will probably continue as more irrigable lands are developed. The present irrigation water requirement in the east side area is about 1,000,000 acre-feet per year; by the year 2020 this water requirement will be about 1,240,000 acre-feet per year.

Increased diversions of surface waters from east side streams are reducing the anadromous fish populations. Although adequate flows exist above the valley floor line, access for fish from the Sacramento River to these reaches is often cut off by lack of water in the lower reaches where the irrigation diversions occur. During many years this access is cut off before all the spring-run salmon can get above the valley floor; consequently many spring-run salmon die without spawning. A similar problem exists for fall-run fish.

Spring and winter floods cause damage to agricultural lands along streams in the east side area. The frequency and severity of damage varies from stream to stream, but some flood problems exist along all of the streams in the area.

Projects Evaluated During This Investigation

During the course of this investigation, several possible water development projects were evaluated. Figure 2 (page 34) shows the locations of these projects. They are divided according to stream groups and discussed separately in the following paragraphs. Those projects considered likely for near future construction are discussed in detail in Chapter 4.

Inks and Paynes Creeks

Inks and Paynes Creeks are the northernmost streams in the east side area and have a combined mean annual runoff of 58,000 acre-feet. Wing Reservoir site on Inks Creek is the only good reservoir site in this area. Paynes and Battle Creeks are both possible sources of supplemental water supply for this reservoir.

Antelope Creek Group

The Antelope Creek hydrographic unit, made up of Salt, Antelope, and Little Antelope Creeks, has a mean annual runoff of 123,000 acre-feet. Four possible water development projects were studied in this area: (1) a large reservoir, Cone Grove Reservoir, on Antelope, Salt, and Little Antelope Creeks, on the valley floor; (2) an alternative to the first, consisting of three reservoirs (Tuscan, Hogback, and DeHaven) in the mountainous areas of Salt, Antelope, and Little Antelope Creeks; (3) a plan that would substitute Facht Reservoir, upstream, for Hogback Reservoir on main Antelope Creek; and (4) the storage project selected as having the best chance for future construction, consisting of Belle Mill Reservoir on Salt Creek, on the valley floor, a flood diversion structure on Antelope Creek, and a flood channel from Belle Mill Reservoir to the Sacramento River. In addition to these projects there is a fifth alternative which probably has the best chance for near future construction. This alternative would be a simple channel improvement and levee system plan. It would not include any reservoir storage.

Mill and Deer Creeks

Plans have been developed for possible projects on Mill and Deer Creeks, streams which have a great potential for water development projects (their combined mean annual runoff is 420,000 acre-feet). Any plan for the development of these streams would include construction of a large storage reservoir at Deer Creek Meadows in the upper Deer Creek drainage area.

The plan selected (the Mill-Deer Project) considers development of the water resources potential of Deer Creek for fish, wildlife, recreation, water supply, and flood control. This plan would include two diversion dams (Morgan Springs on upper Mill Creek and Ishi on lower Deer Creek), a large storage reservoir (Deer Creek Meadows) on Deer Creek, a small off-stream storage reservoir (Crown) on lower Brush Creek, and a series of conduits (Childs Meadows, Yahi, and Vina). Possible future additions to this plan include a power development on the mid-reaches of Deer Creek (comprised of Sugarloaf Reservoir and a series of conduits and powerhouses) and the enlargement of Crown Reservoir. Current studies indicate that power production is not an economically justified purpose for water resource developments in the east side area. However, power features could be added to the Mill-Deer Project if they become economically justified in the future.

Big Chico and Butte Creeks

Big Chico and Butte Creeks are the southernmost streams in the east side area and have a combined mean annual runoff of 325,000 acre-feet. An additional 50,000 acre-feet is imported to Butte Creek from the West Branch of the Feather River by the Pacific Gas and Electric Company. Possible water development projects studied in this area included: Jonesville Reservoir on Butte Creek; Forks of Butte Reservoir on Butte Creek; Web Hollow Reservoir on Big Chico Creek; Castle Rock Reservoir on Butte Creek; and several alternative methods of delivering water to the Cohasset, Forest Ranch, and Paradise Ridges. The Jonesville Project (comprised of Jonesville Reservoir and a series of gravity diversion systems) shows good indications of being suitable for near future construction.

Conclusions

The Sacramento Valley East Side Investigation study area is rich in natural resources, including water, timber, irrigable lands, and fish and wildlife. The orderly and timely development of these resources is essential to the future economic growth and expansion of this area.

More than 98 percent of the east side area's present water requirement, about 1 million acre-feet per year, is used for agricultural purposes. This water comes from ground water and surface diversions from the east side streams, and the Sacramento and Feather Rivers. Irrigation diversions on the valley floor take nearly all of the summer flows from the major east side tributaries.

There has been very little development of the water resources of the east side area. Runoff from the area, amounting to about 1.2 million acre-feet on a mean annual basis, is almost completely uncontrolled since there are no existing reservoirs having more than a few thousand acre-feet of storage. The area needs water development projects to conserve this runoff and to allow residential development in prime mountainous plateau lands; supply additional irrigation water; provide enhancement flows for trout, salmon, and steelhead; and provide flood control.

There will be a large increase in water requirements in the east side area in the future; the present requirement of 1 million acre-feet per year will increase to about $1\frac{1}{4}$ million acre-feet by 2020. Only 48 percent of the gross irrigable lands in the area is presently irrigated. The 1960 population of 69,000 will increase to an estimated 370,000 by 2020.

The east side area's future water requirements will be supplied from a combination of sources. Ground water and major surface water developments (the State Water Project and the Central Valley Project) are capable of providing for the major future water requirements of the east side area at very favorable rates. Therefore, the local projects formulated during this investigation are designed primarily to solve the unique problems of the area that cannot best be met by these sources. These problems include: (1) the need for enhancement of recreation resources to satisfy the growing statewide demands for outdoor recreation opportunities; (2) the need for domestic water supplies in areas that are topographically beyond the reach of the major water supply sources; (3) the need for local flood protection; and (4) the need for preservation and enhancement of the valuable anadromous fishery populations of the area. Results of this investigation indicate that the following four multiple-purpose projects have a good potential for future construction.

1. Mill-Deer Project - centered about a proposed Deer Creek Meadows Reservoir on upper Deer Creek. Surplus water would be diverted to the reservoir from Mill Creek by means of the Morgan Springs diversion dam via the Childs Meadow Conduit. Water would be rediverted to terminal storage in Crown Reservoir on Brush Creek via the Ishi diversion dam and Yahi canal. This multiple-purpose project would produce 20,000 acre-feet per year of new water for local irrigation and 18,000 acre-feet per year of new yield at the Sacramento--San Joaquin Delta. It would increase Deer Creek salmon and steelhead runs by about 18,000 fish per year, and would ultimately provide for about 1,500,000 visitor-days of fishing and other types of water-associated recreation use per year. If constructed in 1970, this project would have a capital cost of $30,400,000 and a benefit-cost ratio of 1.20:1.

2. Wing Project - consisting of a dam and reservoir on Inks Creek, a diversion dam and conduit to deliver surplus water from Paynes Creek to the Inks Creek drainage, and water-associated recreation facilities. The project would be operated for recreation and yield to the Sacramento--San Joaquin Delta. The project would have a gross storage capacity of 244,000 acre-feet, an annual yield of 28,000 acre-feet, and a capital cost of $9,910,000. If constructed in 1970 it would have a benefit-cost ratio of 1.16:1.

3. Jonesville Project - consisting of a dam and reservoir on upper Butte Creek and a series of gravity diversion dams and conduits to deliver domestic water supplies to the Cohasset, Forest Ranch, and Magalia-Paradise Ridges. The project would also provide water-associated recreation opportunities. The reservoir would have a gross storage capacity of 46,000 acre-feet and an annual yield of 25,000 acre-feet. This project would have a capital cost of $11,490,000. Although this project is not presently economically justified, the growing demands for water and recreation opportunities will enable this project to show economic justification by about 1975.

4. Belle Mill Project - consisting of a dam and reservoir on Salt, Little Salt, and Millrace Creeks; a flood diversion system from Antelope Creek; downstream channel improvements on Salt and Millrace Creeks; and water-associated recreation facilities. This project would be operated for flood control and recreation. This project would have a capital cost of $11,500,000. Although this project is not presently economically justified, the rapidly increasing population

and property values in the floodplain and the ever-increasing demands for water-associated recreation will probably enable this project to show economic justification by the year 2000.

Recommendations

It is recommended that:

1. The Wing Project on Inks Creek and the Mill-Deer Project on Mill and Deer Creeks, comprising the best initial development of these waters, be considered by local, state, and federal agencies comtemplating future developments to meet local needs and/or export demands on the Sacramento-San Joaquin Delta.

2. Butte County initiate the formation of an appropriate county-wide or local water district to study the Jonesville Project on Butte Creek. And that this district, once formed, explore the possibility of early construction of the Jonesville Project to provide domestic water supplies to the Paradise-Magalia, Cohasset, and Forest Ranch areas. In the event that the project size shown herein exceeds that proposed by the district, participation by the State under Section 12880 (f) of the Davis-Grunsky Act be considered to insure services to the entire area.

3. The U. S. Army Corps of Engineers continue investigation of a solution to flood problems on Antelope Creek in Tehama County utilizing storage and channelization works as proposed in the Belle Mill Project, or a justifiable alternative thereto suitable to local interests and the Department, and seek authorization for construction at the earliest possible date.

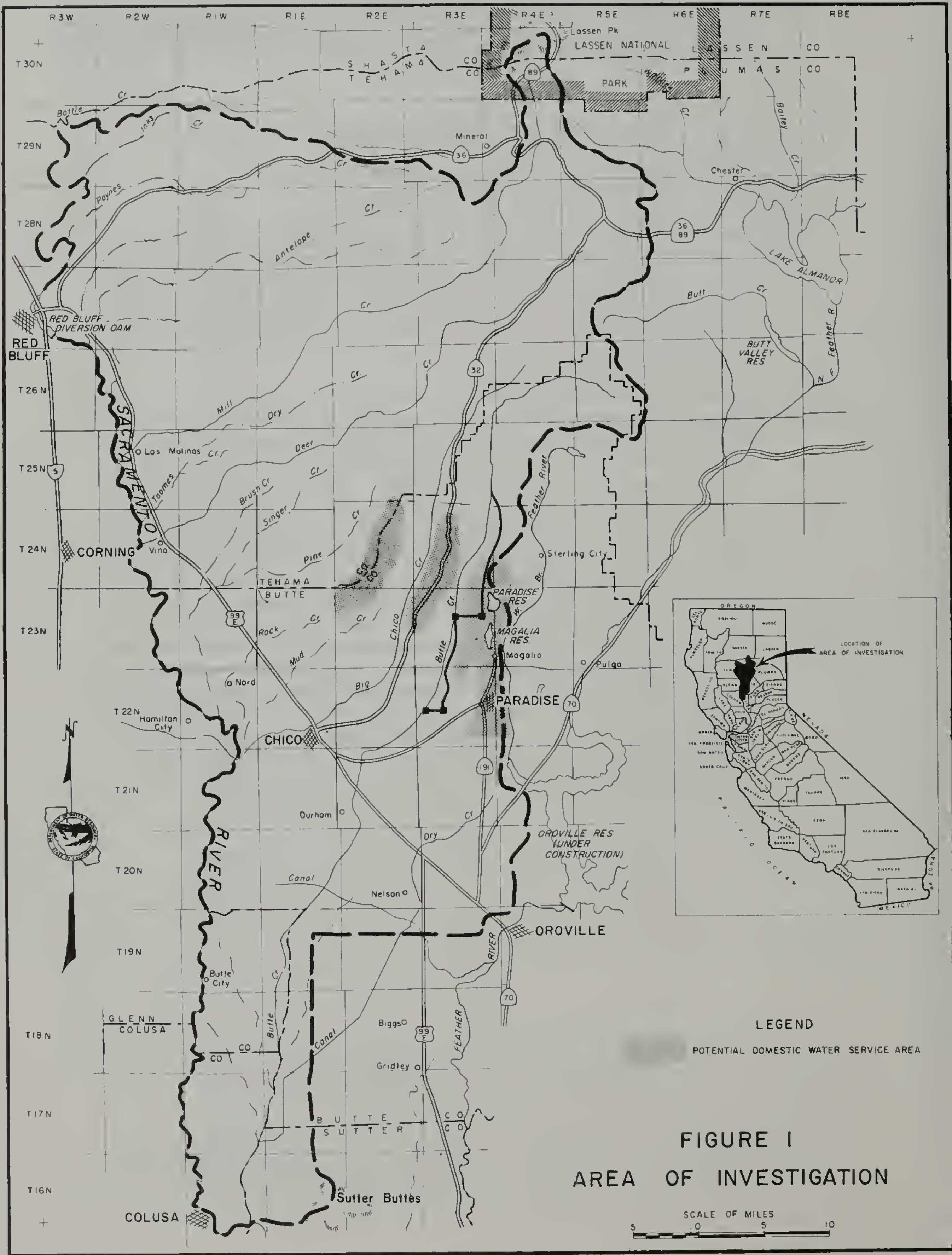


FIGURE I
AREA OF INVESTIGATION

CHAPTER 2. AREA OF INVESTIGATION

The Sacramento Valley East Side Investigation study area covers 2,000 square miles in the northeastern portion of the Central Valley drainage basin of California. This area includes Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks, and several small tributary streams. Runoff from this area, amounting to about 1.2 million acre-feet on a mean annual basis, is almost completely uncontrolled since there are no existing reservoirs having more than a few thousand acre-feet of storage.

The area under investigation is made up of valley and mountainous lands lying east of the Sacramento River on the western slopes of the Sierra Nevada and Cascade Ranges. It comprises the eastern half of Tehama County and a portion of Butte County lying east of the Sacramento River. The area includes the entire drainage basins of Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks, and contiguous portions of the Sacramento Valley floor. It is bordered by the Battle Creek Divide on the north, the Feather River Divide on the east, the Sutter Buttes on the south, and the Sacramento River on the west. About 700 square miles of the 2,000-square-mile investigation area are on the Sacramento Valley floor. The elevation of the area varies from about 50 feet above sea level near the mouth of Butte Creek to 10,457 feet at Lassen Peak in the Cascade Range.

Natural Features

Topographically, the Sacramento Valley east side area can be divided into three general areas. The western portion is made up of the relatively flat lands of the Sacramento Valley floor. The eastern portion consists of rugged mountains of the Sierra Nevada and Cascade Ranges interspersed with high mountain meadows. Between these areas is a transitional or foothill area composed of steep canyons, sharp ridges, and broad plateaus. This latter area is noted as one of the most impassable in the State and it is no coincidence that Ishi, the last wild Indian in North America, was able to hold out here until 1911.

The area is drained in a southwesterly direction by several streams cut deeply into their surroundings. These streams are distinguished from others in the Sierra Nevada by their relatively high and stable summer flows and by their steep descent from the headwaters to the valley floor with few tributaries and little opportunity for storage development. The stream systems are deeply entrenched in the volcanic formations that cover almost the entire area.

While large portions of the valley lands are conducive to agricultural development or are presently irrigated, there are portions of these lands that are classified as nonirrigable due to extreme rockiness. Lands that have possibilities for agricultural development in the near future are limited generally to the better lands along the valley floor.

The foothill or low mountainous areas include several broad ridges which are very conducive to residential development, including permanent and summer tracts, and commercial enterprises such as motels, resorts, restaurants, etc. However, water supplies to serve these areas would involve extensive and expensive conduits. Consequently, agricultural development along these ridges is not expected to accelerate appreciably within the foreseeable future. Domestic requirements, on the other hand, can be expected to support the anticipated high costs of water and can therefore be expected to develop in the near future. The three best potential areas of this type are the ridge lands north of Paradise and the Forest Ranch and Cohasset Ridges.

One of the most unusual features of the area of investigation is the Butte Basin. This basin is the most northerly of the natural flood relief basins flanking the Sacramento River. It lies east of the Sacramento River and extends from the vicinity of Chico on the north to the vicinity of Meridian on the south. Its eastern boundary is an indefinite line along the gently sloping lands rising from the trough of the basin toward the Sierra Nevada foothills. The basin is about 40 miles long and from 1 to 13 miles wide and encompasses an area of about 270 square miles. During floods as much as 1,000,000 acre-feet of water may collect and be temporarily stored in the basin.

Many studies have been conducted to determine the feasibility of constructing a levee project for flood protection in the upper basin. Difficulties in financing, opposition from local landowners, and opposition from sportsmen groups have prevented the construction of large-scale projects in the area. These studies, however, have all been concerned with the construction of single-purpose flood control projects in the upper basin. Some time will be spent during the Department's recently initiated Upper Sacramento River Basin Investigation evaluating the possibility of constructing a multiple-purpose project in the Butte Basin. This project should continue to consider flood control as a primary project purpose, but it should also include recreation, wildfowl management, and fisheries enhancement as possible project purposes.

Geology

The Tuscan formation is the predominant geologic unit in the east side area. It has a vertical thickness of 2,000 feet or more of mudflows (tuff-breccias and breccias) with interlayered agglomerate, tuff, gravel, and some lava flows. In the upland areas, the Tuscan formation consists primarily of andesitic to basaltic mudflows, with minor tuff beds and occasional lava flows. Along the east side of the valley, fanglomerate overlies the Tuscan formation in many areas. The fanglomerate is a well cemented conglomerate which was deposited in a series of coalescing alluvial fans that formed a continuous apron along the edge of the valley during the Pleistocene age. Since then, the fans have been deeply cut by streams entering the east side of the valley. During the Recent geologic age, the Sacramento River and its tributaries deposited alluvium in narrow floodplains overlying fanglomerate.

The Sacramento Valley occupies the northern part of the Great Valley structural trough. The northeastern edge of the valley is formed by the Chico monocline. This monocline, formed by deformation of the Tuscan formation, is reflected by the abrupt, straight escarpment along the northeastern edge of the valley. Uplift on the east side of the Chico monocline apparently occurred during the early Pleistocene age. This uplift was accompanied by the rapid erosion of the Tuscan formation and contemporaneous deposition of the fanglomerate. Renewed uplift in the late Pleistocene or early Recent ages rejuvenated east side streams and caused the deep dissection of the fanglomerate.

Climate

Because of the wide ranges in elevation within the investigational area, precipitation and temperature vary greatly. The mean annual precipitation varies from less than 20 inches in the lower valley lands to more than 75 inches along the divide between Butte Creek and the Feather River in the vicinity of Philbrook Reservoir. The valley lands experience hot and dry summers and mild winters, whereas the upper areas experience cool summers and cold winters, with heavy snowfall.

Between the extremes of temperature and precipitation of the valley and high mountainous areas, there exist several areas between the 1,000- and 3,000-foot elevations where precipitation and summer and winter temperatures are moderate. The major portion of the precipitation occurs from October through May; practically no precipitation occurs on the valley floor from June through September. The higher mountainous areas, however, may experience rainfall in any month of the year. These great variations in climate cause considerable differences in length of the growing season and crop adaptability.

Soils

Soils of the east side area vary markedly in composition, depth, and other physical and chemical properties. These variations are the result of differences in mode of deposition, parent material, age, and climatic factors. They can be divided into five groups: (1) alluvial deposits adjacent to the Sacramento River; (2) the basin and basin rim soils; (3) the soils of the alluvial fans formed by the east side tributaries; (4) the terrace soils; and (5) the upland soils.

The soils of the recent and young alluvial deposits adjacent to the Sacramento River channel are, in general, deep fertile and adapted to a wide variety of crops including orchard. However, in parts of this area, seepage from high prolonged flows in the river has caused a high water table which is a detrimental factor adversely affecting the optimum use of the land.

A large body of soil existing in the southwestern portion of the study area consists of nearly flat lands which make up the basin and basin rim soils. Characteristically these soils are dark colored, fine textured and poorly drained. In some areas they are characterized by high alkali and salt content. Rice, grain and certain shallow rooted field crops are grown on these soils.

Alluvial fans with generally smooth relief and gentle slope project outward in a westerly direction from the base of the east side foothills. The soils of these alluvial fans are deep, well drained and fertile. Examples of the intensive agricutural use of these soils can be observed in the vicinity of Chico and Vina where orchard, truck and field crops are grown. Soils of this type are generally suited to all climatically adapted crops.

Terrace soils are found adjacent to the foothills in this area and have large accumulations of clay in the subsoil, a hardpan or both. The poorer of the terrace soils have developed from material of volcanic origin. Under dry-farmed conditions the best of the terrace soils is limited to the production of grain. When under irrigation certain shallow-rooted crops do well, but perhaps their best use is irrigated pasture. Under irrigation, the poorer terrace soils would be suited to the production of fair to poor pasture, but under present economic conditions it is doubtful if development will take place.

The last of the five soil types are the upland soils. The upland soils best suited to irrigated agriculture are those located at mid-elevations on Paradise, Eden Forest Ranch, and Cohasset Ridges. These soils are generally deep, well drained, have a favorable topography and are well suited to the production of grapes and deciduous orchard. With the exception of Paradise Ridge, where commercial crops have been produced under irrigation, these soils are presently devoted to timber production. The upland soils at the lower elevations consist largely of soils formed on gently sloping to broadly undulating plains and ridge tops. These soils are developed from volcanic material and are of generally poor quality. They are cobbly and extremely shallow, which limits their use to dry land range for cattle and sheep. With the exception of scattered alluvial mountain meadows, the high elevation upland soils are best suited for use as range land and timber production.

Development

The first white men to enter the east side area were probably Spanish explorers traveling up the Sacramento River. However, except for occasional visits by fur trappers, it was not until 1843, and the explorations of Peter Lassen and General John Bidwell, that settlers were enticed to the area. Numerous land grants were made by the Mexican government following surveys conducted by General Bidwell. The early settlers, who were attracted by the abundance of game and luxuriant growth of grasses, came soon after Peter Lassen's acquisition of a Mexican land grant of over 22,000 acres. Their first agricultural pursuits were the raising of grain.

The discovery of gold at what is now Bidwell's Bar on the Middle Fork of the Feather River had a substantial effect on the population growth in the east side area. Many of its people departed for the gold fields. As the easy diggings began to wane, many miners returned to former activities and settlements again expanded. Saw mills and flour mills were constructed to process the raw materials produced in the area. The Lassen Ranch, with other properties, was later acquired by the Leland Stanford interests who developed the world famous Stanford Vina Ranch. There were 7,000 acres of grapes planted on this ranch, and it was the world's largest vineyard at that time.

Just after the turn of the century a wild Indian called Ishi turned up in Oroville. Taken to the University of California at Berkeley and questioned by experts in the field of Indian culture, Ishi told a startling story. He was the last survivor of a stone age Indian tribe called Yanas, which had inhabited California for some 2000 years. This tribe, fearful of the white man's ways, isolated themselves from the outside world in the almost impenetrable hill country of the Mill and Deer Creek drainage basins. Here in the bountiful virgin back country, Ishi and others of his tribe survived in the primitive stone age manner of their ancestors for over a half century after the coming of the first white men.

The two counties which make up the bulk of the east side area, Butte and Tehama, were founded in 1850 and 1856, respectively.

Today, agriculture is the leading industry in the valley floor portion of the east side area, with livestock raising comprising a major segment of this agricultural economy. The early grain farming showed that irrigation was needed for reliable crop production. The first irrigators took full advantage of the stable spring-fed flows of the east side streams by diverting available water without the necessity of constructing expensive storage reservoirs. Today, irrigation diversions on the valley floor take nearly all of the flows from the major east side tributaries. Ground water pumping has developed in recent years to supplement these diversions and increase the firm irrigation water supply.

The production of lumber constitutes an important segment of the economy of the upper or mountainous portion of the investigational area. Substantial precipitation in the mountainous area is conducive to the growth of timber.

The mining industry is of minor significance in the east side area.

Diversity of activities makes recreation an important resource of the east side area; perhaps the most important resource of the upper area in the near future if present trends continue. The east side streams have substantial summer flows which make them particularly desirable for trout fishing. The Sacramento River, which forms the western boundary of the investigational area, provides a great recreational resource in the form of salmon and steelhead angling. This river also provides resident trout, striped bass, black bass, sunfish, catfish, and sturgeon angling. The east side streams provide important spawning areas for the salmon and steelhead runs of the Sacramento River.

Deer hunting is important and very productive in the mountainous eastern section. The foothill area is utilized extensively as winter range. The California State Department of Fish and Game maintains a large game refuge in the winter range area in eastern Tehama County. Bobcat, mountain lion, and wild pig offer limited sport. Upland game, including rabbits, squirrels, pheasants, quail, dove, and bandtailed pigeon are plentiful and provide considerable recreation. The Butte

Sink in the southern portion of the area is one of the most important wetland areas in the Pacific flyway wintering grounds. Some of the best waterfowl hunting in the world is found here. This sport has considerable economic significance to the local communities. The Department of Fish and Game maintains the Gray Lodge Waterfowl Management Area in the area to provide refuge for migrating waterfowl, to provide public hunting, and to reduce depredation of crops by waterfowl.

The timbered lands at the higher elevations provide many camping and picnic areas. A portion of Lassen Volcanic National Park is in the northern part of the area of investigation. This world-famous park attracts throngs of summer vacationists. There is a good winter sports center in the park, near the southern entrance. Many accommodations for travelers are available in the City of Chico and along the highways throughout the area. Richardson Springs, near Chico, is a well known private mineral spring resort.

Transportation facilities in the valley portions of the east side area are good. The Southern Pacific Railroad traverses the southern half of the east side of the Sacramento Valley, crossing to the west side at Los Molinos. U. S. Highway 99E traverses the entire length of the valley. In addition, state, county, and private roads crisscross the valley area at numerous locations. In the upper portions of the area, transportation facilities are not so extensive. State Highway 32 extends northeast through the area from Chico, up the divide between Chico and Butte Creeks, then across Chico Creek and into the Deer Creek drainage where it connects with State Highway 36 and 89 in Deer Creek Meadows. Another highway, the Skyway, connects the town of Paradise with Highway 99E south of Chico. State Highway 36 and 89 also traverse the extreme northern portion of the investigational area.

Access to the remainder of the upper area is available only by dirt roads and by rough jeep trails, most of which are closed to travel during the winter months. Ponderosa Way bisects the investigational area in a north-south direction and may be traveled by automobile during the summer months. The old Lassen Trail, Mark Trail, Buena Vista Trail, Deer Creek Flat Jeep Trail, and other private roads and trails provide very limited access between Highway 99E and Ponderosa

Way. These roads can only be traveled by jeep or truck, and then only during dry weather.

Existing Water Resources Facilities

There has been very little development of storage on the streams of the east side area. While nearly all of the summer flow of the east side streams is utilized by diversion and extensive distribution systems, the only storage reservoirs of any size are located on little Butte Creek. These are Magalia (3,540 acre-feet) and Paradise (6,530 acre-feet) Reservoirs, which are owned and operated by the Paradise Irrigation District.

The Pacific Gas and Electric Company utilizes the natural flow of Butte Creek, together with imported water from the West Branch Feather River, for hydroelectric power generation at De Sabla and Centerville Powerhouses on Butte Creek. The company has recently modernized these plants to improve their efficiency.

The U. S. Army Corps of Engineers has recently completed the Mud Creek Bypass to supplement the Lindo Channel; together, these systems give the City of Chico excellent flood protection from Big Chico Creek.

There has been extensive levee construction along the Sacramento River and in the Butte Basin by both governmental and private organizations. However, in the Butte Basin some of these works actually conflict with each other, and there is a need for coordination and improvement of these systems. In recognition of this need, the State Reclamation Board has recently adopted a master plan of development of flood control features in the Butte Basin.

Mount Lassen - The Northernmost Point in the Sacramento Valley East Side Investigation Area

CHAPTER 3. WATER SUPPLY AND WATER REQUIREMENTS

The east side area in general has an abundance of water but the water is not always in the right place at the right time. The future will see large increases in the demand for water; if the area is to develop to its full potential, the water supply must be developed to meet the growing requirements.

Water Supply

The sources of water supply in the east side area are precipitation in the form of rain and snow, tributary surface and subsurface inflow, drainage from adjoining irrigation districts, and imports from the Feather River. A portion of this supply is used within the east side area, but most of it drains from the area through the Sacramento River and the Sutter Bypass System.

Precipitation

The great range in elevation of the east side area causes a correspondingly great variation in quantity and type of precipitation. Winter storms moving inland from the Pacific Ocean deposit light precipitation as they cross the floor of the Central Valley and begin to lose moisture at increasing rates as they are lifted and cooled in their passage over the Sierra Nevada and Cascade Mountain ranges. Precipitation during the winter months normally occurs as snow above the 5,000-foot elevation.

An isohyetal map of the east side area was prepared from precipitation data gathered from previous investigations. This isohyetal map, depicting lines of equal depth of precipitation, was used during this investigation to analyze the water supply conditions in the east side area. This map shows the pattern of seasonal precipitation and shows that the total mean seasonal precipitation varies from about 16 inches on the valley floor near the Sutter Buttes to more than 20 inches in Red Bluff and to more than 70 inches in the mountainous area near

Butte Meadows. These isohyetal lines are shown on Figure 2, "Possible Plans for Development", page 34.

Surface Water

Surface runoff is the major source of water supply in most of the area. Present developments utilize a very large portion of the summer flows from the east side tributaries, but there are very few storage developments to utilize winter flows. There is presently no significant irrigation water use above the valley floor, and, except in the Paradise Ridge area, domestic water requirements are minor.

Stream Gaging Stations and Records. The flow of the streams in the area has been measured for many years under a cooperative program of the United States Geological Survey and the Department of Water Resources and by other public and private agencies. Long-time records are available for stations at or near the edge of the valley floor for most of the area's major streams. Table 1 lists the stream gaging stations, their DWR index number, and the period of record at each station.

Runoff Characteristics. Both rainfall and snowmelt supply the streams of the east side stream group. Variations in topography, vegetative cover, and geologic structure of the various watersheds affect the pattern and regimen of runoff.

Although precipitation occurs principally in the winter months, the carry-over effect of snow packs causes high spring runoff in the basins with headwaters at high elevations. Precipitation percolates into the volcanic formations of the area, and the gradual discharge from these formations results in high summer flows for many of the streams in the area, notably Deer and Mill Creeks. The annual runoff varies considerably from year to year, depending on the total precipitation. Summer flows, however, do not vary greatly. In fact, the maximum recorded runoff of Deer and Mill Creeks from July through October is less than twice that of the average runoff from the same period. The minimum runoff for these months has never been less than half of the average.

The presence of porous geologic formations in the lower reaches of many of the streams in the area causes a loss of surface runoff, resulting in ground water recharge in the valley areas.

TABLE 1

STREAM GAGING STATIONS

DWR Index No.	Name of Station	Period of Record
A0-0600	Lindo Channel near Chico	1956-
4220	Edgar Slough near Chico	1955-
4225	Rock Creek near Nord-Cana Road	1954-1955
4226	Rock Creek at Griffith Ranch	1954-1955
4229	Pine Creek at Highway 99E	1954-1955
4233	Pine Creek at Meridian Ranch	1954-1955
4238	Pine Creek at Bell Ranch	1952-1955
4241	Mud Creek at Bell Road	1954-1955
4243	Mud Creek at Cohasset Road	1953-1954
4245	Big Chico Creek near Mouth	1948-1956
4250	Big Chico Creek at Chico	1956-
4265	Butte Creek near Durham	1958-
4280	Little Chico Creek near Chico	1958-
4320	Deer Creek near Highway 99E	1948-1958
4420	Mill Creek near Mouth	1948-
4440	North Fork Mill Creek near Los Molinos	1959-
4450	North Fork Mill Creek near Mouth	1948-1959
4520	Antelope Creek near Mouth	1948-1957
4620	Paynes Creek near Red Bluff	1949-
4910	Little Chico Creek Diversion near Chico	1958-
5175	Gold Run Tributary near Nelson	1959-1960
A4-1110	Butte Creek near Chico	1930-
1500	Butte Creek at Butte Meadows	1960-
2210	Big Chico Creek near Chico	1930-
3110	Deer Creek near Vina	1911-
3150	Deer Creek at Polk Springs	1928-1931
3160	Deer Creek below Slate Creek, near Deer Creek Meadows	1961-
3175	Deer Creek at Deer Creek Meadows	1928-1932
4110	Mill Creek near Los Molinos	1909-
4180	Mill Creek near Mineral	1928-1932
5110	Antelope Creek near Red Bluff	1939-
	Imports into Butte Creek above Station near Chico	1930-

Estimated mean monthly distribution of natural runoff at selected stations in the area is presented in Table 2. These values express the mean monthly flow in percent of the mean annual flow and depict typical patterns of runoff for the major east side streams.

TABLE 2

ESTIMATED MEAN MONTHLY DISTRIBUTION OF NATURAL RUNOFF AT SELECTED STATIONS IN THE EAST SIDE AREA 1/

(In percent of seasonal total)

Stations	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
Paynes Creek at Red Bluff	0.7	5.1	18.5	23.3	24.5	16.2	7.6	3.0	0.7	0.2	0.0	0.2	100.0
Antelope Cr. at Red Bluff	2.7	4.5	11.7	12.8	17.5	14.6	13.5	[illegible]	5.3	2.8	2.4	2.3	100.0
Mill Cr. at Los Molinos	3.3	5.0	9.6	10.3	13.2	12.0	13.0	13.2	9.3	4.9	3.2	3.0	100.0
Deer Creek at Vina	2.9	4.4	10.5	11.3	16.1	14.8	15.1	11.1	5.6	3.1	2.6	2.5	100.0
Big Chico Cr. at Chico	2.0	3.8	11.9	14.9	21.1	17.8	13.5	6.5	3.2	2.0	1.7	1.6	100.0
Butte Creek at Chico 2/	2.4	4.0	10.1	12.2	17.3	15.6	15.6	10.9	5.1	2.7	2.1	2.0	100.0
Average	2.3	4.5	12.1	14.1	18.3	15.2	13.0	9.1	4.9	2.6	2.0	1.9	100.0

1/ For the mean period from October 1, 1921, through September 30, 1961.

2/ Does not include imports into Butte Creek by Pacific Gas and Electric Company from West Branch Feather River.

<u>Quantity of Runoff</u>. Estimates of natural and impaired runoff in the east side area were made from available streamflow records, from correlations with the runoff of nearby streams, and from correlations with precipitation records.

The 40-year period from October 1, 1921, through September 30, 1961, was selected as the mean period for water supply studies because of the availability of data and because the period includes the critical dry period of record. The mean runoff for this 40-year period is 98.5 percent of the estimated mean for the 50-year period from October 1, 1912, through September 30, 1962.

This same 40-year period was utilized in conducting reservoir operation studies. Since it includes a critical dry period (1924 through

1934) and a series of above normal years, it is suitable for all aspects of water supply planning.

Estimates of mean monthly runoff at selected locations in the area are presented in Table 3.

TABLE 3

ESTIMATED MEAN MONTHLY NATURAL RUNOFF AT SELECTED STATIONS IN THE EAST SIDE AREA 1/

(In 1,000 acre-feet)

Stations	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
Paynes Creek at Red Bluff	0.3	2.2	8.0	10.1	10.6	7.0	3.3	1.3	0.3	0.1	0.0	0.1	43.3
Antelope Cr. at Red Bluff	2.5	4.1	10.7	11.7	16.0	13.3	12.3	9.0	4.6	2.6	2.2	2.1	91.5
Mill Creek at Los Molinos	6.8	10.1	19.6	21.0	26.8	24.4	26.5	26.8	18.8	10.0	6.6	6.0	203.4
Deer Creek at Vina	6.2	9.6	22.6	24.5	34.8	32.1	32.6	23.9	12.1	6.8	5.7	5.3	216.2
Big Chico Cr. at Chico	1.9	3.6	11.3	14.2	20.1	17.0	12.8	6.2	3.0	1.9	1.6	1.5	95.1
Butte Creek at Chico 2/	5.6	9.3	23.3	27.9	39.9	35.9	35.9	25.0	11.8	6.1	4.8	4.5	230.0

1/ For the mean period October 1, 1921, through September 30, 1961.

2/ Does not include imports into Butte Creek by Pacific Gas and Electric Co. from West Branch Feather River.

Imported and Exported Water

Water is imported into the east side area above the Sacramento Valley floor at only one point. This is the Pacific Gas and Electric Company's import to Butte Creek from the West Branch Feather River. About 50,000 acre-feet are imported annually and utilized for hydroelectric power generation at De Sabla and Centerville Powerhouses on Butte Creek.

Valley floor lands in the east side area utilize water from the Sacramento and Feather Rivers by direct diversion and through ground water pumping. This water can originate from many places outside of the area, including the westside and upstream drainages of the Sacramento River, nearly the entire Feather River drainage, and the north coastal areas as imports to the Sacramento River Basin.

The portions of these water supplies that are not utilized are drained from the east side area by the Sacramento River and the Sutter Bypass system.

Ground Water

Considerable information is available on depths to ground water, ground water elevations, and usable ground water storage in the valley floor portions of the east side area. However, no comprehensive study has been made to determine safe yields or accurate costs of ground water pumping in this area. There is an urgent need for studies to accurately determine the availability and cost of ground water as a source of future water supply.

An analysis of the limited data gathered during previous investigations indicates that large quantities of high quality ground water can be obtained throughout the valley floor portions of the area. It is estimated that the average present cost of ground water pumping in the valley floor areas is about $6 per acre-foot (including well development and pumping costs). This cost was used during this investigation as an alternative cost to surface water developments when conducting cost allocation studies for projects to serve valley floor areas. Although no determination of safe yield was made during this investigation, it is believed that ground water will provide a major portion of the future supplemental water requirements in the valley floor portions of the east side area.

Quality of Water

Surface waters in the east side stream group are generally of excellent mineral quality and are suitable for most beneficial uses. Most of the water from east side streams can be classified as calcium bicarbonate in type. These waters are characterized by low total dissolved solids, chlorides, boron, and fluoride, and are generally soft to moderately hard.

Sacramento Valley ground waters in the east side area are generally of good quality, reflecting the recharge from east side streams. They are generally calcium bicarbonate in type and total hardness varies from slightly hard to very hard. These waters are of excellent quality for irrigation and domestic uses; however, quality problems do exist for some industrial uses.

Water Requirements

Two facts stand out concerning the water requirements of the east side area: (1) More than 98 percent of the water presently used in the area is used for agricultural purposes; and (2) only 48 percent of the gross irrigable land in the area is presently irrigated.

Large increases in both agricultural and urban requirements are forecast for the future. Present and projected land use, service areas, and agricultural and urban water requirements are discussed in the following paragraphs.

Land Use

Predictions of future water requirements require a thorough knowledge of the nature and extent of present land and water uses. Therefore, land use and land classification studies were conducted in the area of investigation from 1960 through 1962; the results of these studies are discussed in the following paragraphs.

Land Classification. Calculations of future water requirements are based mostly on the classification of lands with regard to their potential for irrigated agriculture and recreational development. In general, the amount, location, and crop adaptability of irrigable lands must be determined.

During 1961 and 1962, a land classification survey was conducted by the Department of Water Resources. Lands were grouped into four major categories: (1) irrigable lands, (2) urban lands, (3) recreational lands, and (4) miscellaneous lands.

Irrigable lands (lands which are suitable for irrigated agricultural development) were classified according to their physical and chemical properties which include topography, soil texture, rockiness, effective rooting depth, degree of soil profile development, high water table, and concentration of saline and alkali salts.

Urban lands are those lands devoted to urban uses at the time of the survey. It is recognized that future urban expansion will encroach upon some of the irrigable land; the effect of this is taken into account when future agricultural development is projected.

Much of the Sacramento Valley floor and mountain region within the east side area is suitable for some recreational use, such as hunting, fishing, camping, and summer homes. However, the land classification survey delineated only those lands which are suitable for permanent and summer home tracts and camp and trailer sites; i. e., those developments which might require water service. Primary considerations given to the classification of recreational lands were (1) aesthetic values, such as view, nearness to lakes and streams, and density and type of forest canopy; (2) the plans of private owners and national and state organizations; and (3) such physical factors as soil depth, slope, and rockiness.

Two types of lands are included as miscellaneous lands. These are (1) irrigable forest and forest range lands, and (2) swamp and marshlands. The irrigable forest and forest range lands are found at higher elevations within the area. These lands have physical characteristics which make them suitable for irrigation. However, due to climate and other factors associated with their present use, these lands have been mapped as best suited to remain under forest or range management. Swamp and marshlands are those lands which generally have water standing on them, and usually support heavy phreatophytic, or water-loving, plant growth such as tules and cattails.

Present Land Use. A detailed survey of land use in the area was conducted during 1961 to gain a thorough knowledge of the nature and extent of present land and water uses.

The survey showed there were 206,000 acres of land irrigated and 16,000 acres of land devoted to urban uses. Of the 206,000 acres of irrigated land, 33 percent was planted to rice, 24 percent to orchard, 15 percent to pasture, 13 percent to miscellaneous field crops, 9 percent to truck crops (including tomatoes), and 6 percent to alfalfa. Only 1620 acres of this irrigated land were located above the Sacramento Valley floor. Of these, 20 acres are planted to alfalfa, 1180 to pasture, 10 to truck crops, and 410 to orchard.

Future Land Use. Future crop patterns were projected for the area of investigation to provide a means of estimating future water requirements. It should be recognized that crop patterns vary considerably during any series of years because of new technology, crop rotation, changing economic conditions, or other factors. The projected crop patterns therefore are intended only as representative of future conditions.

Projections of land use pattern were made through 2070 (Table 4). In preparing these projections, particularly for the valley floor portion of the area, strong reliance was placed upon the results of a California crop market outlook study conducted by the Department. This study developed estimates of future demand for California crops. While this outlook study extended only to the year 2020, land use projections for the east side studies were extrapolated to the year 2070.

It should be mentioned that even in the most intensively developed areas of irrigated agriculture, not all of the irrigable lands receive water every year. Such factors as farm lots, roads, canals, fallow lands, difficulty of development, and urban encroachment were accounted for in making the crop projections.

As the population of California increases, it is expected that urban encroachment on those deciduous orchard and truck crops now grown adjacent to metropolitan areas of the State will increase, and the production of these crops will shift to suitable lands in less populated areas. For this reason, large increases of these crops are projected in the east side area.

Population projected in the urban and suburban areas indicates a large increase in the demand for water for these purposes. Employment in the present agricultural and timber products economy supports, either directly or indirectly, about one-third of the population. By 2020, employment in these two fields is expected to double. Recreation and recreation-oriented services will provide employment for a large portion of the remaining population, but other industries are not expected to constitute very much of the economy. The land projected to future urban and suburban uses is shown in Table 4.

TABLE 4

LAND USE PATTERNS IN THE

SACRAMENTO VALLEY EAST SIDE INVESTIGATION AREA

IN THOUSANDS OF ACRES

Land Use	1961 Use	Projected Future Use 1970	1980	1990	2000	2035*	2070*
1. Irrigated Lands							
Orchard	49	57	64	73	80	97	103
Sugar Beets	5	6	7	8	9	10	11
General Field	22	27	32	35	40	48	51
Tomatoes	4	4	5	6	7	7	8
General Truck	16	18	20	21	23	27	28
Alfalfa	12	13	13	14	14	12	9
Pasture	31	32	35	36	37	40	38
Rice	67	67	66	65	65	63	63
Subtotal	206*	224	242	258	274	305	311
2. Urban Lands	16	22	29	36	44	65	76
3. Non-irrigated, Irrigable Lands	224	202	180	158	136	87	72
4. Nonirrigable Land and Other Misc. Nonserviceable Lands	954	952	949	948	946	943	941
Total	1,400	1,400	1,400	1,400	1,400	1,400	1,400

* It should be noted that statewide projections are not available beyond the year 2020. Values for subsequent dates are extrapolated from the 2020 base.

Service Areas

For this investigation the valley floor lands were not divided into separate service areas. Actual service area boundaries would logically be determined during any later specific project feasibility study.

Three rural domestic service areas were delineated and designated as the Eden Service Area, the Forest Ranch Service Area, and the Cohasset Ridge Service Area. In addition, the existing Paradise Irrigation District was considered as a potential service area for supplemental water from possible east side projects. The three domestic service areas are shown on Figure 1. These service areas and the valley floor area are described in the following sections.

The Valley Floor Area. About 700 square miles of this investigation area lie on the Sacramento Valley floor, an area that will account for the majority of future supplemental water requirements. There are many possible sources of additional water supply to these lands. These include: storage developments on east side streams, increased ground water pumping, diversion from the Sacramento River, service from Oroville Reservoir, and new storage developments in the Feather River drainage. Future water requirements will undoubtedly be met by a combination of these developments, with ground water pumping playing a major role.

Eden Service Area. This service area comprises about 20,000 acres of prime mountainous plateau lands on the ridge north of Paradise between Butte Creek and the West Branch Feather River. Lack of adequate water supplies has hindered residential development in this area. Ground water is available, but deep (600-700 feet) wells are required and there is no assurance that extensive supplies exist. This area could be served by gravity diversion or pumping from either Butte Creek or the West Branch Feather River.

Forest Ranch Service Area. This service area comprises about 15,000 acres of prime mountainous plateau lands on the ridge between Butte Creek and Big Chico Creek. Conditions here are very similar to those in the Eden Service Area. A water supply for this area could be developed from either Big Chico or Butte Creek.

Cohasset Ridge Service Area. This service area comprises about 10,000 acres of prime mountainous plateau lands on the ridge between Big Chico Creek and Pine Creek. Conditions here are also very similar to those in the Eden Service Area. The best source of water for this area is Big Chico Creek, with the possibility for some storage development on Upper Butte Creek.

Paradise Irrigation District. This district comprises about 12,000 acres of prime mountainous plateau lands on the ridge between Big Chico Creek and the West Branch Feather River. The community of Paradise has experienced a rapid population growth, but excellent local planning has kept pace with this growth, and their water supply system is modern and adequate for their present needs. The community is considering the addition of two sources of supplemental future water supplies -- importation from the West Branch Feather River through the purchase of a water right from the Diamond National Corporation, and the enlargement of their existing Magalia Reservoir. However, even if they are successful in both of these ventures, population projections prepared for this investigation indicate that eventually they will have to turn to large storage developments to provide for their long-term future needs.

Urban and Agricultural Requirements

Water requirements for urban lands were determined by applying estimated unit water requirements to the projected population. The estimated current unit water requirements are based on historical urban water use. Some of the factors considered in evaluating future unit water requirements are (1) character of the anticipated urban complex, (2) unit consumptive use, (3) water use efficiency, and (4) internal household use.

Irrigation water requirements, or the gross quantity of water which must be delivered to the farm headgate to supply the projected crop requirements, were estimated by calculating the amount of applied water required for each crop type. Appropriate allowances were made for irrigation losses.

Irrigation water is obtained by surface diversions from the east side streams, by surface diversion from the Sacramento River, by surface diversion of imported water from the Feather River and by pumping of ground water from the excellent ground water basins which underlie the area of investigation.

Crops associated with livestock production will continue to play an important role in the future. However, there will be large increases in water requirements for other crops. There will also be a large increase in the amount of urban and suburban water requirements for this area. The population in the investigation area was estimated at 69,000 in 1960, and the projected 2020 population is estimated at 370,000. Table 5 summarizes the projected water requirements for the area.

TABLE 5

PROJECTED WATER REQUIREMENTS

FOR THE SACRAMENTO VALLEY EAST SIDE INVESTIGATION AREA

IN THOUSANDS OF ACRE-FEET

Use	1961	1970	1980	1990	2000	2035*	2070*
Irrigation	980	1,030	1,080	1,110	1,160	1,230	1,240
Urban	20	30	40	60	80	160	200
Total Water Requirement	1,000	1,060	1,120	1,170	1,240	1,390	1,440

* It should be noted that statewide projections are not available beyond the year 2020. Values for subsequent dates are extrapolated from the 2020 base.

The previously described Cohasset Ridge, Forest Ranch, and Eden service areas, together with the Paradise Irrigation District, will have large future water requirements due to rapid population growths in these areas. The total population of these ridge areas was 12,600 in 1960; by the year 2000, projections indicate that the population will increase to nearly 74,000. Table 6 presents the projected future population and the associated water requirements for these areas.

There are many sources of supply for the future water requirements presented in Tables 5 and 6. Projects outlined in Chapter 4 of this report could provide most of the water requirements presented in Table 6 and a small percentage of the water requirements presented in Table 5. The southern portions of the investigation area, which will have large future water requirements for agricultural use, will meet their future demands through increased ground water pumping and increased use of surface water supplies. Included in their potential future sources of surface water are (1) Oroville Reservoir, (2) upstream projects on the Feather River, and (3) direct diversion of Central Valley Project water from the Sacramento River.

An analysis of future water requirements and potential sources of water supply indicates that ground water plus the State Water Project and the Central Valley Project are capable of providing for the major future water requirements of the east side area at very favorable rates. The water problems that cannot be solved by these sources will have to be solved by local developments. The local projects formulated during this investigation are designed to answer such problems, which include: (1) the need for enhancement of recreation and fisheries resources to satisfy the growing statewide demands for outdoor recreation opportunities, (2) the need for domestic water supplies in areas that are topographically beyond the reach of the major water supply sources, (3) the need for local flood protection, and (4) the need for preservation and enhancement of the valuable anadromous fishery populations of the area.

TABLE 6

PROJECTED POPULATIONS AND TOTAL

WATER REQUIREMENTS IN ACRE-FEET

FOR THE COHASSET, FOREST RANCH, EDEN, AND PARADISE RIDGES

	1961	1970	1980	1990	2000	2035*	2070*
Cohasset							
Population	170	600	2,000	3,200	4,600	8,800	10,000
Water Requirements	50	160	560	930	1,390	2,770	3,250
Forest Ranch							
Population	120	400	900	1,900	3,000	6,520	9,000
Water Requirements	30	110	250	530	870	2,150	2,760
Eden							
Population	600	1,100	2,500	5,500	11,500	24,250	26,000
Water Requirements	160	310	730	1,660	3,480	7,350	7,870
Paradise							
Population	11,745	24,000	36,000	47,000	58,000	91,500	116,000
Water Requirements	3,350	7,260	11,300	14,800	18,200	28,700	36,400

* It should be noted that statewide projections are not available beyond the year 2020. Values for subsequent dates are extrapolated from the 2020 base.

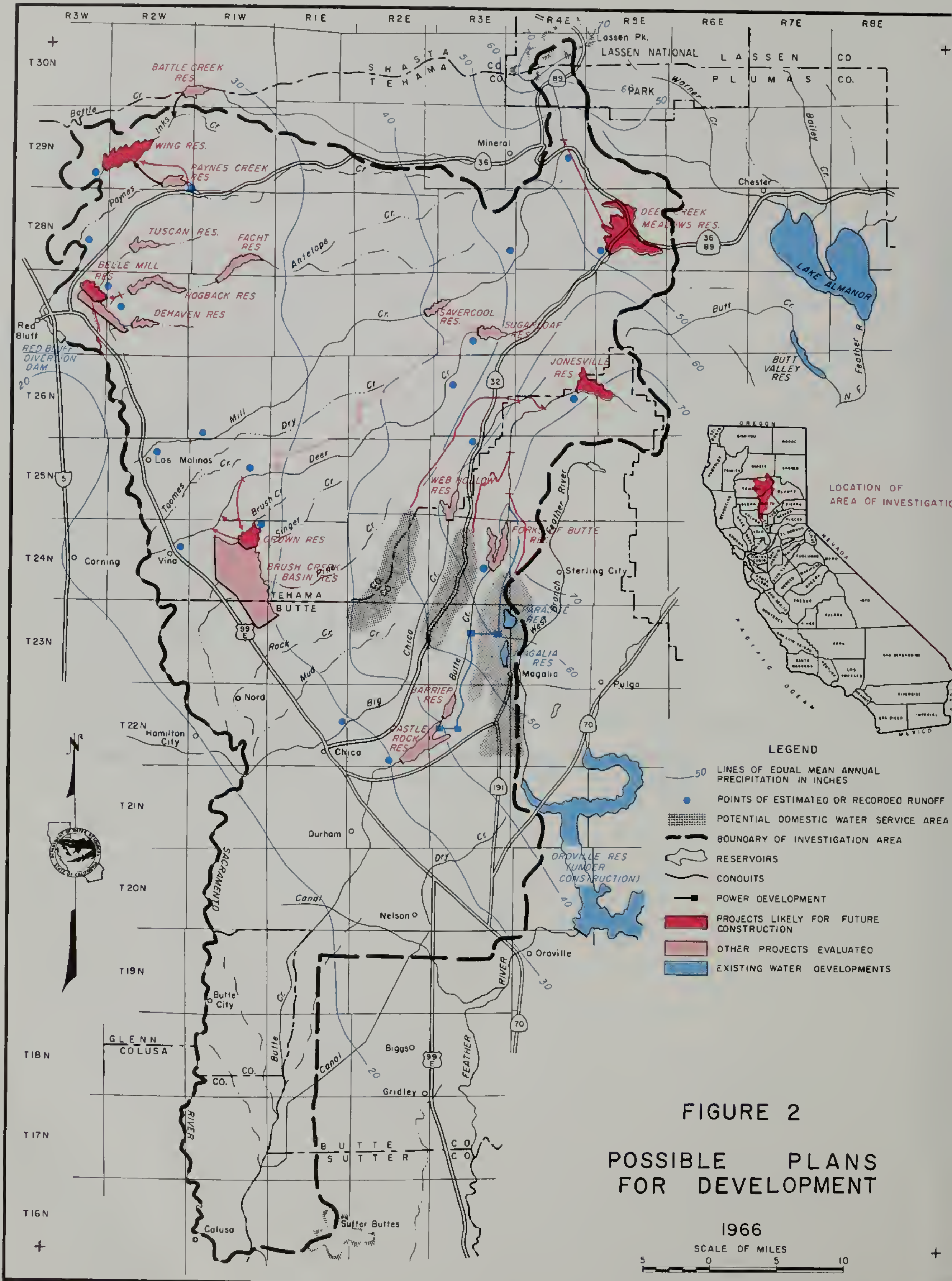


FIGURE 2

POSSIBLE PLANS FOR DEVELOPMENT

1966

CHAPTER 4. PLANS FOR WATER DEVELOPMENT

To ensure proper formulation of east side water development projects, water problems and water requirements were studied, alternative solutions were examined, designs and cost estimates were prepared, and project economic benefits were evaluated.

The multiple-purpose concept of reservoir use was used in analyzing all potential storage projects. Projects were formulated to provide for local irrigation and domestic water requirements, to regulate flows for downstream fishery enhancement, to provide for reservoir recreation, to provide flood control, and to enhance water supplies in the Sacramento-San Joaquin Delta. Due to physical locations, specific local situations, and physical limitations, each of the projects tended to emphasize one or more of the operating criteria and to de-emphasize some of the others. The following criteria were observed in all project planning studies conducted during this investigation:

1. The water supply period of 1921-22 through 1960-61 was used to evaluate reservoir water yields.

2. Downstream users with prior rights were fully provided for in project operations.

3. Areas of origin of water were given first consideration in development of new water supplies.

4. Only primary tangible benefits were used in economic evaluation.

5. All economic analyses were based on a 100-year period of analysis using an annual interest rate of 4 percent.

6. Each project was sized to produce maximum net project benefits.

The first part of this chapter outlines the general criteria used in formulating projects during this investigation. The discussion of general criteria is followed by detailed descriptions of the Mill-Deer, Jonesville, and Belle Mill projects.

Reservoir Operation Studies

The general criteria for operation of east side reservoirs varied from project to project. Reservoirs were operated to provide for local irrigation and domestic water requirements, to regulate flows to provide for downstream fishery enhancement, to provide water for export from the Sacramento-San Joaquin Delta, to develop reservoir recreation, and to provide flood control.

In determining local irrigation water requirements, the following assumptions were made:

1. A demand for water exists only when water can be delivered at a cost within the average payment capacity of crops projected within the project service area.

2. Present and preproject water requirements will continue to be met from existing sources.

3. The project buildup period will be complete within ten years after project completion.

The following table gives the monthly distribution of local irrigation demand used in operating east side reservoirs for new yield.

Month	%	Month	%
January	0	July	22
February	0	August	20
March	1	September	12
April	5	October	4
May	16	November	0
June	20	December	0

In determining local agricultural yields, deficiencies in water supply were allowed during dry years. When the yield is less than the annual demand a deficiency of up to 50 percent is allowed in any one year, but not more than 100 percent of the annual demand is allowed within any consecutive 7-year period.

Local urban water requirements were determined from population projections prepared for the investigation area. Unit per capita use figures were applied to the projected population figures to determine the estimated future water requirements. No deficiencies were allowed in determining project yields for urban requirements.

The Department of Fish and Game has estimated streamflow maintenance and enhancement requirements below each of the project reservoirs. The maintenance requirements were incorporated into all operation studies conducted for this investigation. Enhancement releases were included, when economically justified.

Operation studies were also conducted to determine the amount of project yield that would be available for export from the Sacramento-San Joaquin Delta. Wing Reservoir on Inks Creek was operated to optimize this yield, whereas the other proposed reservoirs were operated primarily for local yield, fisheries enhancement, or flood control with credit being taken for any new Delta yield created by the fisheries releases.

Reservoir storage sufficient to insure protection of reservoir fishlife was maintained at each reservoir. In addition, wherever feasible, maximum reservoir levels were maintained through the summer recreation seasons.

Belle Mill Reservoir on Salt Creek was the only reservoir operated with provisions for a sizable flood storage reservation for local flood protection. However, any reservoir constructed and operated in the Sacramento River Basin will provide some amount of flood protection locally and downstream on the Sacramento River and in the Butte Basin.

Project Benefits

To determine the desirability of a given project, the project accomplishments must be determined and evaluated. The methods of evaluating the different water project benefits are described in the following paragraphs.

Water Supply

The project benefits achieved through provisions of new water supplies for consumptive use were considered in three categories: local irrigation supplies, local domestic supplies, and supplies for export to the Sacramento-San Joaquin Delta.

Benefits accruing to a project that provides a local irrigation supply are determined by subtracting all farm costs, except land and water costs, from the gross farm income. This gives the net return to land and water. The project benefit is the difference between the return to land and water with and without the project.

Benefits accruing to a project that provides a local domestic water supply were computed by determining the maximum amount a beneficiary would be willing to pay for project water. This amount is estimated by considering local income levels, living expenses, the current costs of comparable services, and the cost incurred by the local agency in making the final distribution of domestic water supplies.

Benefits accruing to a project that provides a water supply to the Sacramento-San Joaquin Delta were estimated to be $30 per acre-foot. These benefits were arrived at by deducting the cost of water delivery from the Delta to the service area, from the net benefits to the service area.

Hydroelectric Power

The annual value of benefits attributable to the generation of hydroelectric power from a project is the estimated cost of producing equivalent power from the most likely alternative source expected to develop in the absence of the proposed development, with appropriate adjustment for transmission costs and losses and other technical factors. The assumption was made that the most likely alternative source for east side hydroelectric power plants would be a modern, privately financed steam-electric plant. Based on this assumption, the two-part hydroelectric power benefit was computed as $15.40 per kilowatt-year for the capacity component and 2.75 mills per kilowatt-hour for the energy component.

Preliminary studies using these values showed that development of the hydroelectric power potential of all east side sites would cost more than the expected revenue from power sales. Consequently, the purpose of power development was not included in any of the east side projects.

Flood Control

Flood control benefits were divided into two categories: (1) "local" benefits based on reduction of flood damage along the stream between the proposed dam and the Sacramento River, and (2) "remote" benefits based on reduction of flood damage downstream along the Sacramento River.

Local benefits were determined by using all available flood damage data and converting the damages from floods of record to average annual damages. An estimate of flood damages under proposed project conditions was then made, and the differences between project and preproject flood damages represents the local flood control benefit attributable to the project.

Previous studies, conducted for the Upper Sacramento River Basin Investigation and reported on in Department of Water Resources Bulletin No. 150, indicated that any on-stream reservoir constructed and operated in the Sacramento River Basin would provide some measure of flood protection downstream on the Sacramento River and in the Butte Basin. These studies indicated that a good reconnaissance estimate could be achieved by assuming an annual benefit of 50¢ per acre-foot of active storage. This value was used, where applicable, in evaluating east side projects.

Recreation

Personnel of the Department of Parks and Recreation under contract to the Department of Water Resources conducted studies to predict the recreation use at each of the proposed reservoir sites. These estimates were based on the attractiveness of the recreation pursuit, proximity of similar recreation opportunities, accessibility of the area, and the number of recreationists able to participate. The difference in recreation use (in visitor-days) under "project" and "nonproject" conditions represents the recreation use attributable to the project. Details of the recreation studies conducted for this investigation are presented in Appendix B.

Benefits attributable to each project were determined by multiplying the dollar value of a day's recreation activity by the net number of visitor-days of use. For this reconnaissance investigation, the study area was broken into three general parts and different dollar values were applied to each of the three areas. A value of $2.20 per visitor-day was used in the extreme eastern portion of the investigation area, $1.40 per visitor-day was used in the extreme western portion of the investigation area, and a value of $1.80 was used in the central portion of the study area.

These values were estimated from unit values computed for surrounding areas. The Upper Feather River Basin Investigation used \$2.00. The Box Canyon Feasibility Study used \$2.40. The Upper Sacramento River Basin Investigation used \$1.80. A comparison of the esthetic characteristics at the different projects proposed in these studies led to the selection of the values used in the east side area.

Fish and Wildlife

Personnel of the Department of Fish and Game under contract to the Department of Water Resources conducted studies to determine the effect of possible east side projects on fish and wildlife in the area. There were four fish and wildlife benefits that could be attained by east side projects: (1) enhancement of sport fisheries in project reservoirs, (2) enhancement of non-anadromous sport fisheries below project reservoirs, (3) enhancement of anadromous fisheries below project reservoirs, and (4) enhancement of waterfowl in the Pacific Flyway. Not every project would achieve all of these benefits, but one or more of these benefits was attributable to every east side project. Details of the fish and wildlife studies conducted during this investigation are presented in Appendix C.

Each project reservoir was evaluated to determine the types and numbers of sports fish that it could support. When projected fishing demands greatly exceeded the ability of the project to grow fish, plans were developed to stock project reservoirs with game fish. The high elevation project reservoirs would support good trout populations while the lower elevation reservoirs would support warmwater species. The value of the reservoir fishery was converted to dollars by determining the number of fishing days that it would support and multiplying this by the value of a recreation visitor-day.

Some proposed projects would be operated such that downstream conditions would be improved for resident trout. This benefit was also evaluated by determining the number of additional recreation visitor-days that could be supported and multiplying by the unit value of a visitor-day.

An excellent opportunity exists for enhancement of the anadromous fishery of Deer Creek by the Mill-Deer Project. Department of Fish and Game biologists have evaluated this potential in terms of the number of new spawning salmon and steelhead that could be supported if the project were constructed and operated. These estimates were converted to dollar benefits by determining the amount of the new commercial and sport catch that could be supported by these fish. The benefit accruing from commercially caught salmon is based upon an average dockside price less the cost of harvesting by a reasonably efficient commercial operation. Benefits from sport salmon and steelhead fishing were computed by multiplying the estimated number of fisherman days needed to catch the fish, times the value of a recreation visitor-day.

Designs and Cost Estimates

The preparation of realistic designs and cost estimates is of vital importance in the economic evaluation of water development projects. All cost estimates prepared during this investigation include allowances for costs of engineering, administration, contingencies, and interest during construction. Annual costs were computed for a 100-year capital recovery period and a four percent interest rate with an appropriate allowance added for operation, maintenance, and replacement.

Preliminary designs and cost estimates were prepared for all projects studied during this investigation. Estimates prepared for those projects considered likely for near future construction were reviewed by the Division of Design and Construction and are presented in later portions of this chapter. Detail of these estimates and estimates for other projects studied during this investigation are on file in the Department's Northern District Headquarters in Red Bluff, in the form of an office report.

There were three major support services used in preparing designs and cost estimates for this investigation -- topographic mapping, geologic investigations and right-of-way appraisals.

Topographic Mapping

An extensive program of topographic mapping was conducted for the Sacramento Valley East Side Investigation. These maps were utilized for design of project features and for determination of reservoir depth-area-capacity relationships. Topographic maps at a scale of one inch equals 300 feet, with a 10-foot contour interval, were prepared for the following reservoirs: Morgan Springs and Savercool on Mill Creek, Deer Creek Meadows and Sugarloaf on Deer Creek, Web Hollow on Big Chico Creek, and Jonesville, Forks of Butte, and Barrier on Butte Creek. These maps, together with mapping already available from other agencies (mainly U.S.G.S. quadrangles), provided sufficient topographic coverage for this investigation.

Geologic Investigations

Evaluation of geologic factors is essential in the preparation of plans, designs, and cost estimates for physical features of water development projects. Geologic investigations for the Sacramento Valley East Side Investigation included: study of geologic formations with particular emphasis on the sites of proposed structures, surface geologic mapping of dam and reservoir sites, preliminary foundation drilling, collection of soil samples to determine the properties of available materials, and determination of quantities of available materials. In studying the sites, emphasis was placed on the determination of rock types, degree of weathering, patterns of jointing, the nature and extent of shear zones, and the engineering properties of foundation materials.

Geologic studies for this investigation varied from preliminary reconnaissance of surficial geologic features at some sites to subsurface exploration at other sites. Later sections in this chapter will describe the geologic conditions encountered at those sites considered likely for near future construction. Results of all of the geologic studies conducted for this investigation were recorded in an office report, "Engineering Geology of Damsites, Sacramento Valley East Side Investigation", which is available in the Department of Water Resources files.

Right-of-Way Appraisals

The costs of property to be acquired can be of major consequence in preparing cost estimates for water projects. The Department's Division of Right-of-Way Acquisition prepared property appraisals for all of the east side projects. These appraisals included land values, improvements, and severance costs.

Economic Analysis

All economic evaluations made during this investigation utilized a 100-year period of analysis and a four percent interest rate. Total present worth values of primary project benefits and project costs were computed, with proper inclusions for the present worth of future benefits and future expenditures for additions and for operating and maintaining the project.

Estimated project benefits and project costs were used in conducting two vital economic evaluations -- economic justification and cost allocation. These evaluations are described in the following paragraphs.

Economic Justification

Economic justification is demonstrated through the preparation of a benefit-cost ratio. This ratio is a ratio of the present worth of primary project benefits and the present worth of project costs. A project is considered to be economically justified if its primary benefits exceed its costs; in other words, if its benefit-cost ratio exceeds unity.

Cost Allocations

Cost allocation is the process of apportioning the costs of a multiple-purpose project equitably among the various purposes served by the project. This is an essential step in the economic evaluation process since it provides the basis for determining the amount to be paid by each of the project beneficiaries for the various project services. The allocation embraces all projects costs, including costs of construction, operation, maintenance, and replacement. The concept of cost allocation assumes that the total cost of combining several purposes in a comprehensive project is substantially less than the sum of costs of separate projects provided for each purpose, and that the savings derived through use of multiple-purpose structures should be shared by all purposes.

There are several methods of allocating costs of water development projects. For projects of a general nature, such as those presented in this report, the Department of Water Resources uses the separable costs--remaining benefits method. Briefly, this method involves:

1. Determination of the justifiable cost of including a given project purpose. This is done by evaluating the benefits accruing to that purpose, and further, by limiting the justifiable cost to the least costly alternative method of achieving that benefit.

2. Determination of the separable costs of each purpose. Separable costs represent the difference in cost between the multiple-purpose project with all purposes included, and the project cost with a given purpose excluded.

3. Subtraction of the separable costs from the justifiable costs to determine the remaining benefits.

4. Assignment to each purpose its separable costs plus a share of the remaining joint costs in proportion to the remaining benefits.

The cost allocations presented for this reconnaissance-level planning study are very preliminary but are indicative of the percentages of benefits and costs that will accrue to each of the project purposes. The preparation of refined cost allocations is one of the major purposes of advanced planning or feasibility-level studies and requires much more advanced data than is normally available in a reconnaissance-level study.

Project Selection

The criteria described in the preceding sections of this chapter were used in analyzing numerous alternatives and selecting the most promising projects in the east side area. Of all the projects evaluated during this investigation (see Chapter 1 for a summary of the investigation), four are considered likely for future construction: Mill-Deer, Wing, Jonesville, and Belle Mill. Figure 2, page 34, shows the projects likely for future construction in red, the other projects considered are shown in pink.

Battle Creek Reservoir and Paynes Creek Reservoir were considered as possible components of the Wing Project. Both of these reservoirs would divert water into Wing Reservoir. These reservoirs would provide some flood control and would increase the total conservation yield of Wing Reservoir. The Paynes Creek Diversion was selected as a less costly alternative to Paynes Creek Reservoir. A direct diversion from Battle Creek, with no storage, is considered to be a possible future addition to the Wing Project.

Several alternative projects were studied to provide flood control to the Antelope area east of Red Bluff. Tuscan, Facht, Hogback, DeHaven, and Cone Grove Reservoirs were all studied as possible alternatives to the Belle Mill Project.

A number of plans have been studied both in this investigation and in Bulletin No. 3, "The California Water Plan", to develop the water and natural resources of Mill and Deer Creeks. Savercool Reservoir, Sugarloaf Reservoir, Brush Basin Reservoir, and the Deer Creek power facilities were studied as possible additions to the Mill-Deer Project. Savercool Reservoir was evaluated as a single-purpose recreation reservoir. Sugarloaf Reservoir and the Deer Creek power facilities would develop a large percentage of the hydroelectric power potential of Deer Creek. Brush Basin Reservoir would increase the conservation yield of the Mill-Deer Project. All of these features were eliminated from the Mill-Deer Project due to lack of economic justification. However, some of these features may show economic justification at some future date and could be added to the project.

Web Hollow Reservoir, on Big Chico Creek, was studied as a possible source of domestic water supply for the city of Chico and as a hydroelectric power project. This project was eliminated since ground water appeared to be a less costly alternative and because hydroelectric power failed to show economic justification as a project purpose.

Forks of Butte Reservoir, on Butte Creek, was studied as a possible alternative to the Jonesville Project. This reservoir and a series of high lift pumping plants could serve the same domestic water service areas as Jonesville. Economic analysis showed the Jonesville Project to have the more favorable benefit-cost ratio.

Barrier Reservoir, a small storage development on lower Butte Creek, was studied as a recreation and fisheries enhancement project. However, while the analysis of this project was still underway the Department of Fish and Game installed a fish barrier on Butte Creek near the Centerville Powerhouse. This barrier accomplishes the major objective of Barrier Reservoir, that is to stop spring-run king salmon from migrating above Centerville Powerhouse into an area where they may be subjected to lethal water temperatures.

Castle Rock Reservoir, on lower Butte Creek, was studied as a flood control and water conservation project. However, it was eliminated due to the existence of less costly alternate sources of water supply.

Details of designs and cost estimates prepared for many of these alternatives are available in an office report which is on file with the Northern District.

The remainder of this chapter discusses the projects selected as being likely for future construction -- Mill-Deer, Wing, Jonesville, and Belle Mill.

Mill-Deer Project

The Mill-Deer Project (Figure 3, page 48) is in eastern Tehama County. Surplus water from Mill Creek would be diverted to Deer Creek Meadows Reservoir on upper Deer Creek by means of the Morgan Springs Diversion Dam via Childs Meadow Conduit. Water would be rediverted to terminal storage in Crown Reservoir on Brush Creek via the Ishi diversion dam and Yahi canal. The project would include facilities for water-associated recreation, wildlife habitat development, and fishery enhancement. This project would be operated for recreation, flood control, fisheries enhancement, and yield to the Sacramento-San Joaquin Delta.

Hydrology

The drainage area of the Deer Creek Meadows damsite is about 52 square miles, and the drainage area of the Morgan Springs damsite is approximately 20 square miles. The drainage area of Deer Creek between Deer Creek Meadows and the Ishi diversion dam is 157 square miles and the drainage area tributary to Crown Reservoir is 20 square miles. Monthly flows for the period from October 1, 1921, through September 30, 1961, were computed at the Morgan Springs diversion site, Deer Creek Meadows damsite, Ishi diversion dam, and Crown damsite. Mean annual runoff during this period for these areas was: Morgan Springs, 67,000 acre-feet; Deer Creek Meadows, 48,000 acre-feet; Deer Creek between Deer Creek Meadows and Ishi diversion dam, 168,000 acre-feet; and Crown damsite, 22,600 acre-feet.

A probable maximum flood hydrograph with a peak discharge of 33,500 cfs and a standard project flood hydrograph with a peak discharge of 19,500 cfs were computed for the Deer Creek Meadows damsite. A probable maximum flood of 9,600 cfs was computed for the Crown Reservoir drainage area.

Project Features - Designs and Costs

This section discusses the designs and cost estimates prepared for the Mill-Deer project features. The project layout is shown on Figure 3, and the project features are listed in Table 7.

Mapping

The sites of Deer Creek Meadows reservoir and Morgan Springs Diversion Dam and Childs Meadow Conduit were mapped by photogrammetric means by the Department in 1962 at a scale of 1" = 300' with 10-foot contours to 4,800 feet for the reservoir and to 4,950 feet for the areas of the diversion dam and conduit. The portion of the reservoir map including the damsite, with the contours extended to 4,900 feet, was enlarged to 1" = 200' for use in layouts and calculations of quantity.

The Deer Creek Meadows area and most of the Childs Meadow Conduit area are covered by the USGS Mt. Harkness quadrangle at a scale of 1:62,500 with 80-foot contours. The sites of Morgan Springs Diversion Dam and the upper portion of the canal are covered by the 1956 USGS Mt. Lassen quadrangle at the same scale.

No special mapping was performed for the Crown reservoir site. The entire dam and reservoir area is covered by the USGS 1952 Richardson Springs NW quadrangle at a scale of 1:24,000, with main contour intervals of 20 feet and with most of the damsite covered by supplementary 5-foot contours. The area is also covered at a scale of 1:62,500 by the 1952 Richardson Springs quadrangle, with main contour intervals of 40 feet.

Geologic Mapping and Exploration

In 1963, the Department prepared geologic maps of the Deer Creek Meadows Dam and reservoir area; drilled three core holes and 21 auger holes; and excavated 15 foundation trenches and 27 borrow trenches. Reports of previous work included a Department of Water Resources geologic reconnaissance report dated November 10, 1950; the "Westwood Sheet," by the California Division of Mines, 1960, containing maps of the regional geology; and "Geology Near Mineral, California," a Master's thesis (1960) by T. A. Wilson, University of California, describing a portion of the project area.

In 1964, at the Crown Dam and reservoir site, the Department excavated eight foundation exploration trenches to a depth of 13 feet and obtained data from private well logs and from a 486-foot-deep hole drilled near the damsite by the Department in connection with the Coordinated Statewide Planning program. Regional geology is shown in the "Chico Sheet," California Division of Mines, 1962.

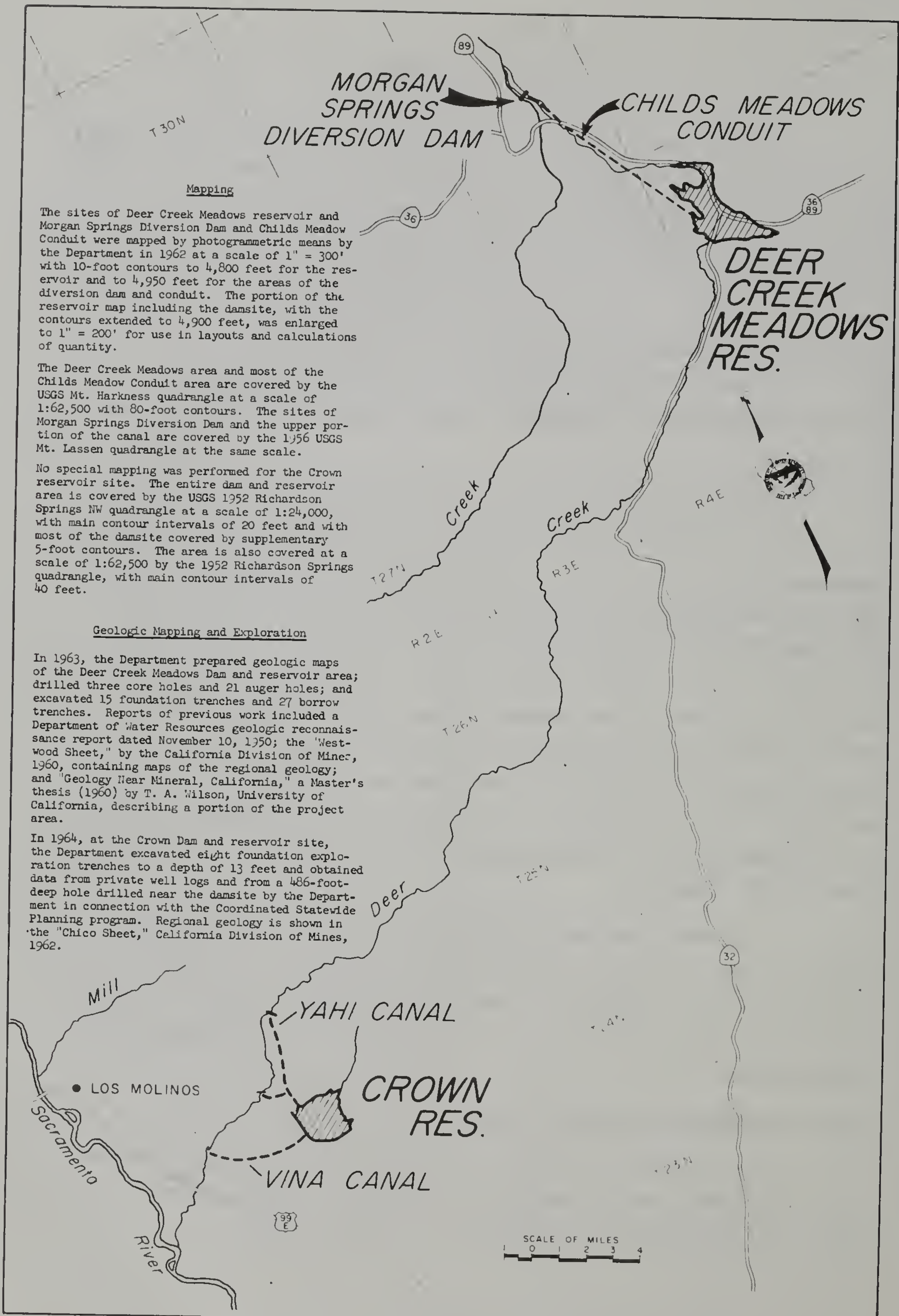


Figure 3. Mill-Deer Project Location Map

TABLE 7

MILL-DEER PROJECT FEATURES

PRIMARY PROJECT PURPOSES

Local irrigation yield, export yield, recreation, and fishery enhancement

DIVERSION FACILITIES (Morgan Springs - Childs Meadows)

Location
- Dam (Morgan Springs) Section 14, T29N, R4E, MDB&M
- Conduit.....Mill Creek to Deer Creek Meadows Res.

Type
- Dam.........................Low concrete gravity
- Conduit..............................Buried pipe

Size or capacity
- Dam height, in feet..........................15
- Conduit capacity, in cubic feet per second....250

DEER CREEK MEADOWS RESERVOIR

Drainage area, in square miles.....................52
Maximum water surface elevation, in feet.........4,719
Normal water surface elevation, in feet..........4,700
Minimum pool elevation, in feet..................4,630
Capacity, at normal pool, in acre-feet.........153,000
Water surface area at normal pool, in acre-feet..2,000

DAM

Location.......SW 1/4 Section 21, T28N, R5E, MDB&M
Type............................Zoned earthfill
Height above streambed, in feet..............193
Crest elevation, in feet....................4,723
Volume of fill, in cubic yards..........3,500,000

SPILLWAY

Type..............................Ungated chute
Design capacity, second feet..............20,000
Elevation of weir crest, in feet...........4,700
Length of weir crest, in feet................ 60

OUTLET WORKS

Conduit type.......................Cut and cover
Conduit size.................................5'
Control type.................Howell-Bunger valve
Control size.................................36"
Energy dissipator..........Impact stilling basin
Design capacity, in cubic feet per second.....175

DIVERSION FACILITIES (Ishi - Yahi)

Location
- Dam (Ishi Diversion) Section 23, T25N, R1W, MDB&M
- Conduit (Yahi Canal)Deer Creek to Crown Reservoir

Type
- Dam...Concrete overpour with earthfill wing dikes
- Conduit......Trapezoidal section with graded spawning gravels

Size or capacity
- Dam height, in feet..........................30
- Conduit capacity, in cubic feet per second....225

CROWN RESERVOIR

Drainage area in square miles 20
Maximum water surface elevation,in feet...........308
Normal water surface elevation, in feet...........304
Minimum pool elevation, in feet...................282
Capacity at normal pool, in acre-feet..........11,000
Water surface area at normal pool, in acres........730

DAM

Location..Section 10, 14 and 15, T24N, R1W, MDB&M
Type.................................Earthfill
Height above streambed, in feet................50
Crest elevation, in feet.....................310
Volume of fill, in cubic yards..........1,300,000

SPILLWAY

Type..............................Ungated chute
Design capacity, in second feet............8,600
Elevation of weir crest, in feet.............304
Length of weir crest, in feet................300

OUTLET WORKS

Conduit type.......................Cut and cover
Conduit size.................................54"
Control type..........................Slide gate
Control size.........................54" x 54"
Energy dissipator......Impact type stilling basin
Design capacity, in cubic feet per second.....350

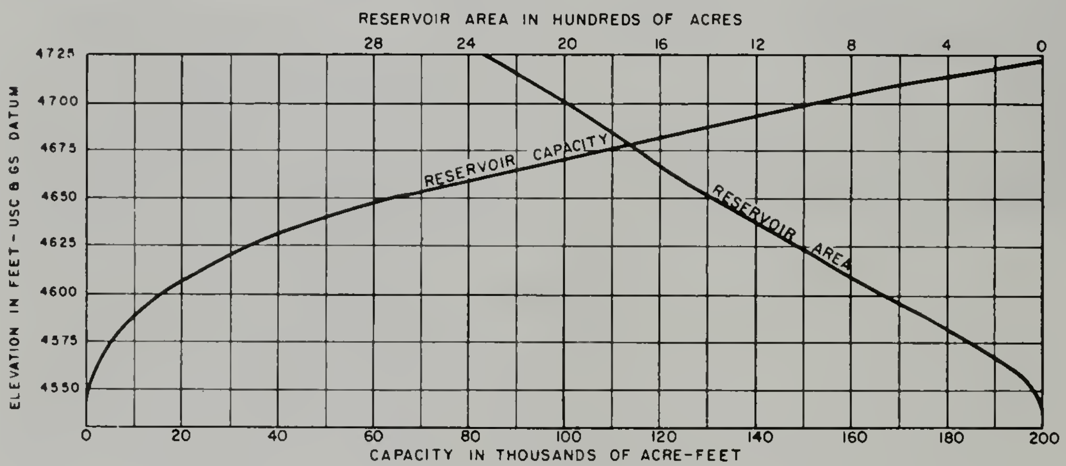
VINA CANAL

Location..Crown Reservoir to Stanford-Vina Dam on Deer Creek
Type..............Concrete lined, trapezoidal section
Capacity, in cubic feet per second................190

Morgan Springs Diversion Dam. This diversion dam would be located on Mill Creek about eight miles northwest of Deer Creek Meadows. The main portion of the dam would consist of a concrete overpour section about 150 feet long and rising about 15 feet above streambed. The weir crest would be at an elevation of 4,915 feet. Two levees with a total length of about 1,200 feet would connect the concrete dam to high ground, impounding a reservoir of about eight acres. The structure would be founded on deep alluvium and glacial deposits. The major items in the cost would be 700 cubic yards of concrete and 20,000 cubic yards of levee embankment.

Childs Meadows Conduit. A buried pipe was chosen to convey Mill Creek water to Deer Creek Meadows Reservoir. Although more expensive than an open canal, a closed conduit was deemed necessary because of the heavy deer use of the area along the proposed alignment and the high recreation potential of the lands traversed by the conduit. Approximately 45,500 feet of steel pipe 72 to 96 inches in diameter would be required to carry the design flow of 250 cfs. Ninety acres of right-of-way would have to be acquired for this feature.

Deer Creek Meadows Reservoir. This reservoir would have a gross storage capacity of 153,000 acre-feet at a normal water surface of 4,700 feet and a surface area of 2,000 acres. Approximately 3,100 acres, of which 500 acres are presently owned by the State, would have to be acquired for the reservoir and recreation development. Reservoir capacity and water surface area at various water surface elevations are shown on the following graph.



AREA-CAPACITY CURVES

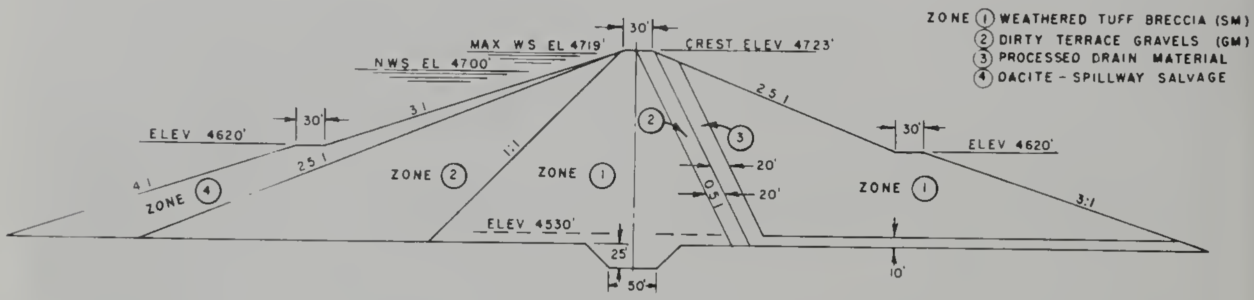
Approximately half of the reservoir area would have to be cleared of timber of varying density. State Highways 36-89 and State Highway 32 would require relocation around Deer Creek Meadows Reservoir. Highways 36-89 would be rerouted along the east shore for a distance of 2.6 miles and Highway 32 would be relocated along the south shore of the reservoir for about 3.5 miles. In addition to public road relocations, a total of about 5.8 miles of private lumber haul roads would have to be constructed to bypass the reservoir. This relocated haul road would parallel the relocated Highway 32 along the south shore, cross the dam crest, and rejoin the existing haul road system.

An artist's conception of Deer Creek Meadows Reservoir

Deer Creek Meadows Dam. This dam would be a zoned earthfill dam, 193 feet high with crest at elevation 4723 feet. Total embankment volume would be 3,500,000 cubic yards. The section would consist of: zones 1 and 2, impervious material; a chimney and blanket drain, zone 3 to provide positive control of seepage through the embankment; and zone 4, rock salvaged from the spillway excavation to provide slope protection and add to the stability of the section under rapid drawdown. Side slopes would be 3:1 on the downstream slope up to elevation 4620 and 2.5:1 above. The upstream slope would be 4:1 to elevation 4620 and 3:1 above. The dam crest and berms at elevation 4620 would be 30 feet in width. The dam layout and geology are presented in Figure 4 on pages 54 and 55.

Foundation preparation would consist of stripping, excavating a 50-foot-wide cut-off trench, and grouting two lines of holes on 10-foot centers to a depth of approximately 70 feet.

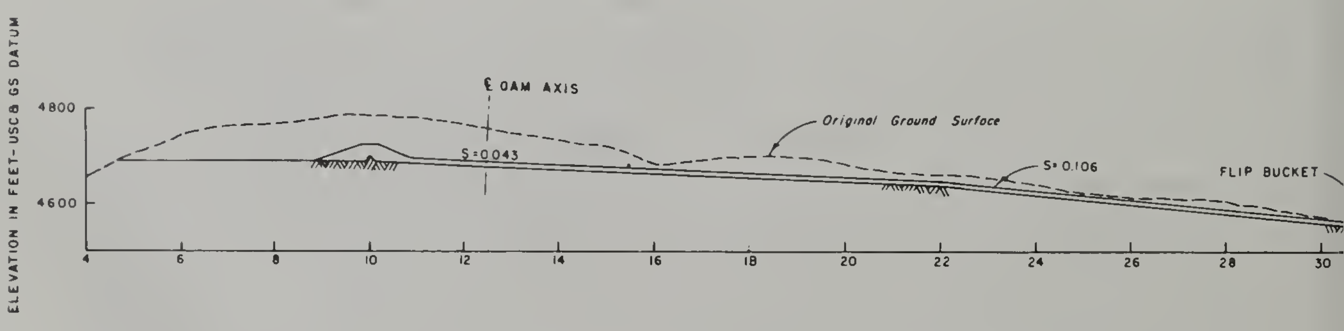
The maximum dam section is shown in the following diagram.



MAXIMUM DAM SECTION

SCALE OF FEET
0 100 200

Deer Creek Meadows Spillway. An uncontrolled overflow, chute-type spillway would be located on the right dam abutment. The 60-foot ogee crest was designed to pass the maximum probable flood (33,500 cfs) with a peak outflow of 20,000 cfs at a maximum head of 19 feet. This would provide the dam with four feet of nominal freeboard. The 2100-foot-long spillway would be lined for its entire length and would terminate in a flip bucket approximately 40 feet above the streambed. The following diagram shows the spillway profile.



PROFILE OF SPILLWAY

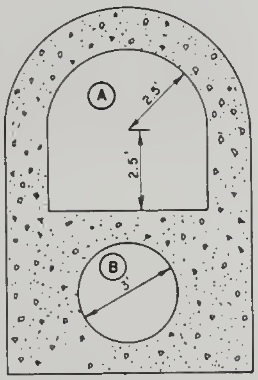
SCALE OF FEET
0 200 400

The location and required length of the spillway and the height above streambed of the flip bucket were dictated by the desirability of founding the entire spillway on the dacite flow capping the right abutment rather than on the underlying tuff. Figure 4 indicates the approximate location of the contact between the dacite and tuff formations.

Out of the total 560,000 cubic yards of excavation for the spillway, approximately 450,000 cubic yards would be used in zone 4 of the dam.

Deer Creek Meadows Outlet Works. Operation criteria require that the outlet works be capable of discharging a minimum of 175 cfs with the reservoir water surface at minimum pool elevation of 4,630 feet. The intake is designed such that water could be drawn from a point near the bottom of the reservoir and from upper points at elevation 4,630, 4,655 and 4,680 feet.

The outlet works would utilize the five-foot cut-and-cover diversion conduit along the right side of the stream channel. After being used for diversion during construction, the cut-and-cover conduit would be adapted to serve as the outlet works.

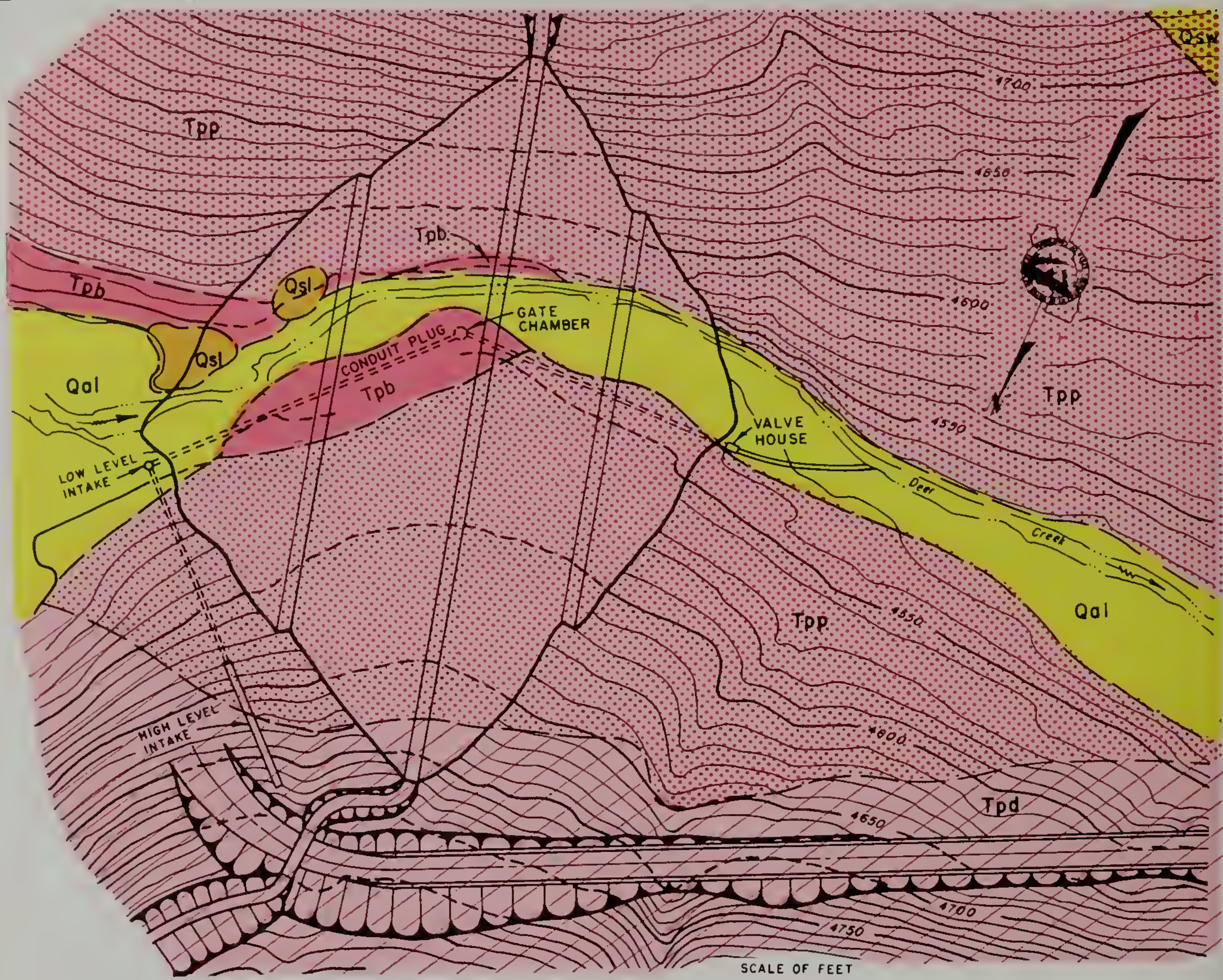


OUTLET CONDUIT
TYPICAL SECTION

Upstream from the gate chamber, channel (A) conveys flow from the low-level intake and channel (B) conveys flow from the high-level intake. At the gate chamber, flow from channel (A) is diverted to channel (B) which conveys the entire release to the valve house, located on the downstream toe of the dam.

The multiple intake criteria would be met by placing a simple submerged intake near the bottom of the reservoir. A multiple-level sloping shuttered intake structure, placed on the dacite formation on the right abutment, would serve as the high-level intake at any operating level.

Figure 4. DEER CREEK MEADOWS DAM



GENERAL PLAN

Pyroclastic rocks would form most of the right abutment of the dam and nearly all of the left abutment. Underlying most of the channel and lower portion of the abutments is a basalt flow, interbedded with the pyroclastics and overlain by recent alluvium. The upper portion of the right abutment consists of Stover Mt. dacite, a volcanic flow. The dacite would be a suitable foundation for the spillway. The foundation is adequate for an earthfill dam but probably not for a heavier rockfill section.

Leakage might occur through the basalt, pyroclastics, and dacite formation within the reservoir area.

The weathered tuff breccia shown on the materials location map would provide an adequate supply of impervious fill material. The terrace gravels would be used for pervious fill and also would be processed for filter material. Riprap would be salvaged from the spillway excavation in the dacite on the right abutment.

LEGEND

Qal Alluvium, deposits in Deer Creek and Deer Creek Meadows; consists of sand, gravel, and fines; includes organic soils in meadows.

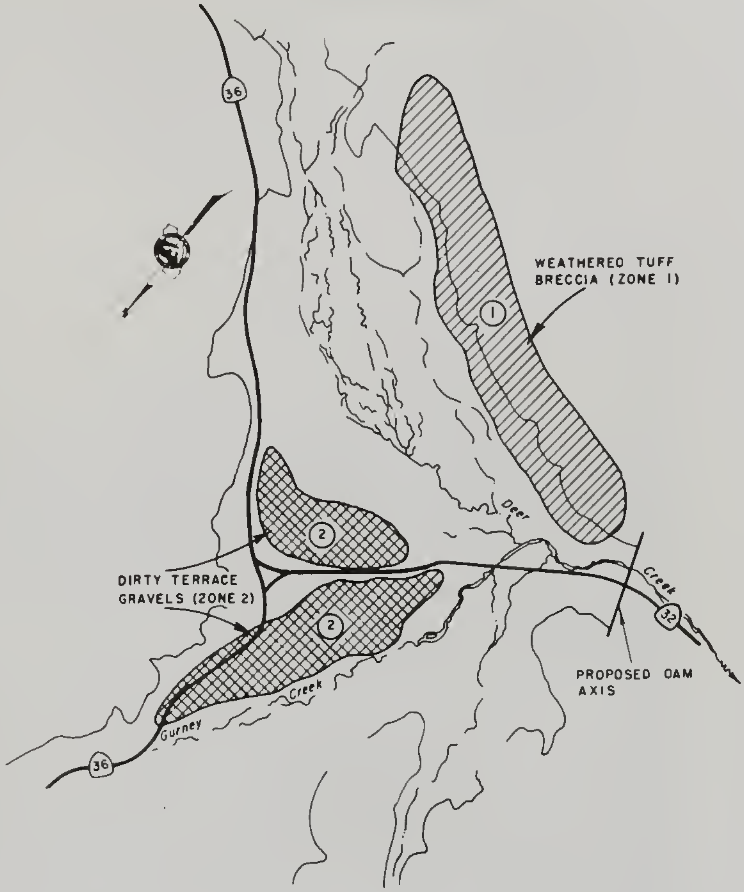
Qsl Slumped soil, deposits in slumped areas in springs and seeps; ranges from organic silts and clays to silty sands, generally unstable in place.

Qsw Talus and/or slopewash, angular blocks of andesite and basalt to 5 feet in diameter, deposited on steep hill slopes below andesite bluffs.

Tpd Stover Mt. dacite, light to medium gray, banded to massive, glassy dacite flow. Underlies the Los Creek rhyolite flow.

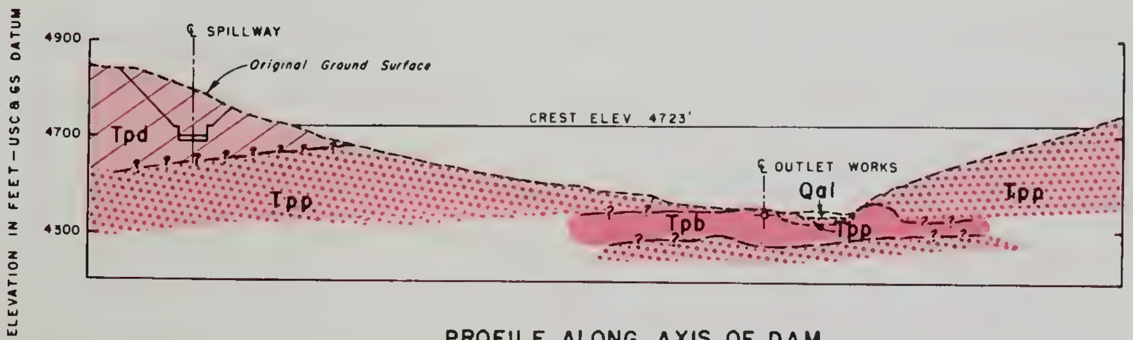
Tpp Deer Creek pyroclastics, reddish brown tuff breccia, lapilli tuff, water deposited tuff, volcanic sandstone and conglomerate, and occasional basalt flows.

Tpb Basalt flow, massive, porphyritic basalt flow, nonvesicular, interbedded with the Deer Creek pyroclastics.



MATERIALS LOCATION MAP

SCALE OF FEET
0 2000 4000



PROFILE ALONG AXIS OF DAM

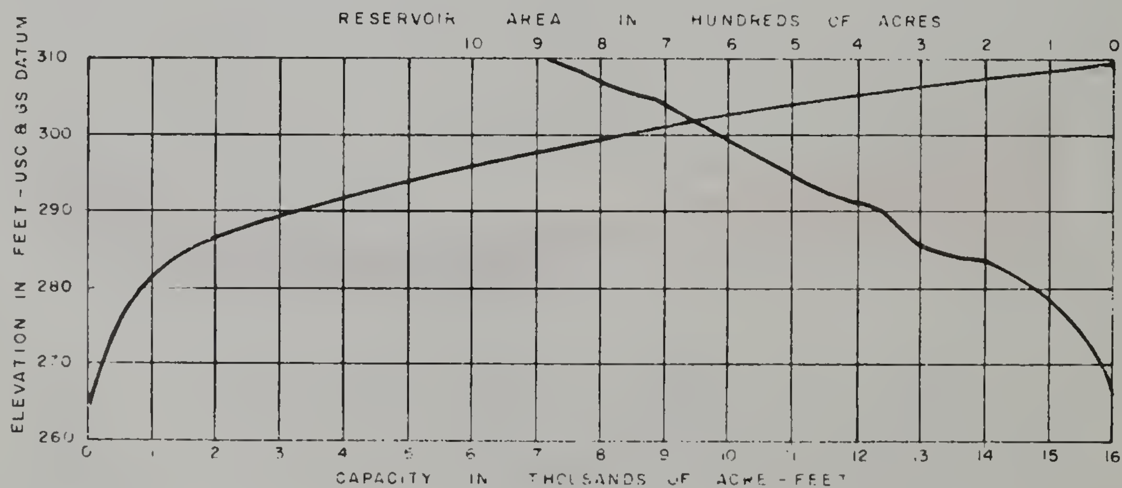
SCALE OF FEET
0 200 400

Ishi Diversion Dam. This diversion structure, on Deer Creek near the foothill-valley floor line, would consist of a concrete dam 30 feet in height with a fish ladder on the right abutment. Water diverted at this dam would flow by gravity into the Yahi Canal.

Yahi Canal. This conduit, with a maximum capacity of 225 cfs, would carry water from the Ishi Diversion Dam into Crown Reservoir. It would also serve as an artificial spawning channel for fall-run king salmon. The channel would have a bottom width of 35 feet and would be about 13,700 feet long. With ten percent of the length devoted to resting pools, silt settling pools, and invert controls, the channel would provide 430,000 square feet of graded gravel spawning area. The channel cross section design would provide suitable spawning conditions at all flows between 100 and 200 cfs. The entire channel length will be fenced and landscaped.

Near the center of Section 34, T25N, R1W, a screened turnout structure would release the main flow into Crown Reservoir. From this point a fish transportation channel (design capacity 15 cfs) would continue back to Deer Creek near the center of Section 33, T25N, R1W. At this point a barrier dam on Deer Creek would lead migrating salmon into the transportation channel to provide them access to the Yahi Canal spawning facilities.

Crown Reservoir. The reservoir, located on the valley floor on Brush Creek, would have a storage capacity of 11,000 acre-feet at a normal water surface elevation of 304 feet and a surface area of 730 acres.



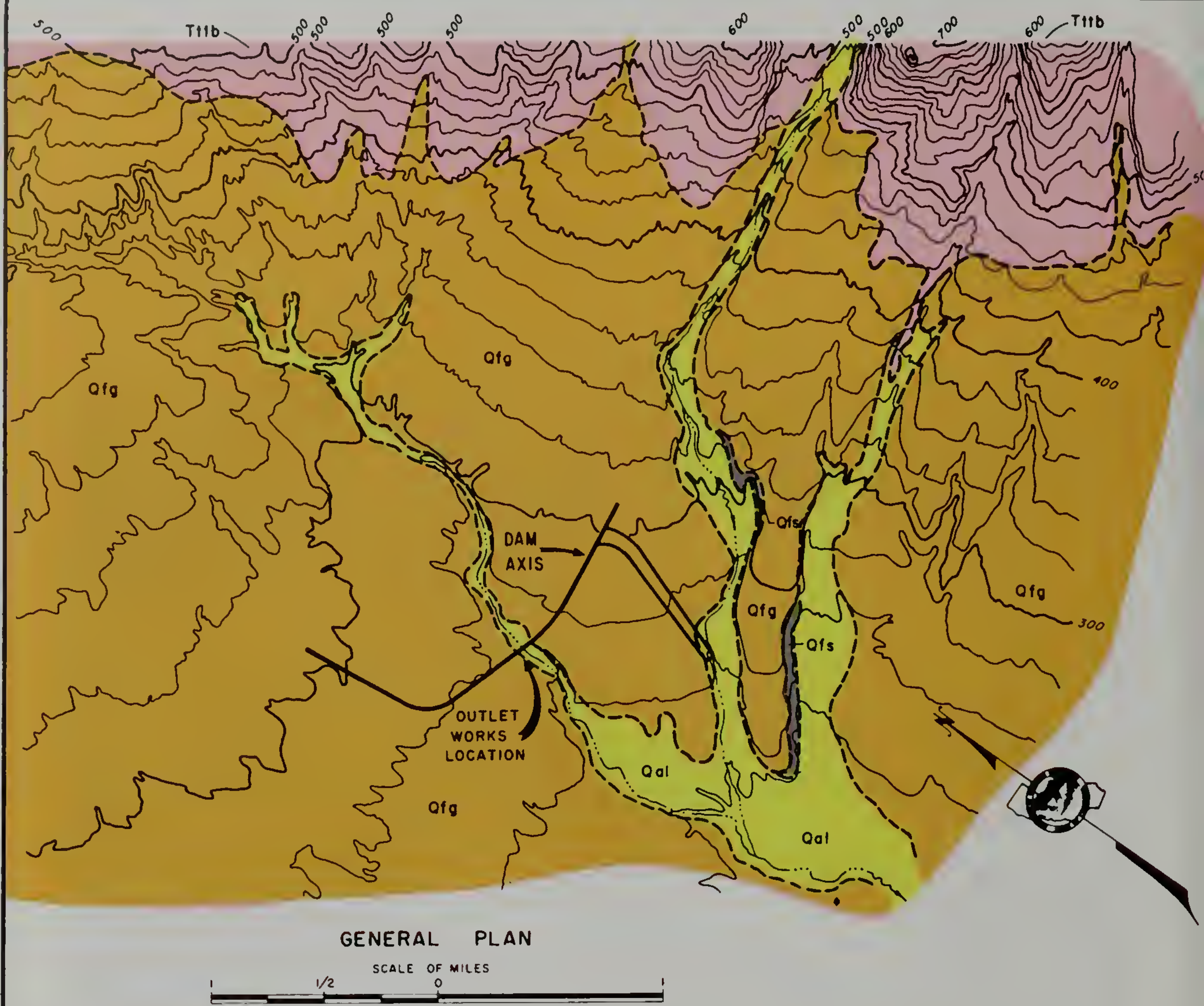
AREA – CAPACITY CURVES

Approximately 1,400 acres would have to be acquired to provide for surcharge storage and water-associated recreation use. Since there are only a few scattered trees in the reservoir area, reservoir clearing would be very inexpensive. The aerial photograph below shows the approximate normal water surface.

An artist's conception of Crown Reservoir

Crown Dam. The dam layout and geology for Crown Dam are presented in Figure 5. The dam would be a zoned earthfill embankment with a 10,200-foot crest length and a crest elevation 310 feet. Maximum height, at the Brush Creek channel, would be 50 feet. The main body of the dam, zone 1, would consist of compacted fanglomerate from the reservoir area, indicated as borrow area 1 on the materials location map (Figure 5). Zone 2 would consist of the same material except that grading requirements would be less stringent and less compaction would be required. Zone 3 would be a chimney and blanket drain of graded sand and gravel. Zone 4,

Figure 5. C R O W N D A M A N D



The most prominent geologic unit at the site is the fanglomerate, continuous deposit of cemented, silty, and sandy gravel which forms most of the upland surface east of Highway 99E between Red Bluff and Chico. Underlying the fanglomerate is the silt member, which ranges from a silty sand to a brown, sandy silt or to a plastic silt. The fanglomerate has an average thickness of about 15 feet, under which the silt member is about 50 feet thick.

The fanglomerate, when processed, would provide a source for the impervious portion of an earth dam. Pervious material is available nearby in the channel of Deer Creek, with limited amounts also available from the channels of Brush and Singer Creeks. There is no source of riprap at the damsite. The closest known source is the basalt flow north of the mouth of Deer Creek, about six miles from the site.

LEGEND

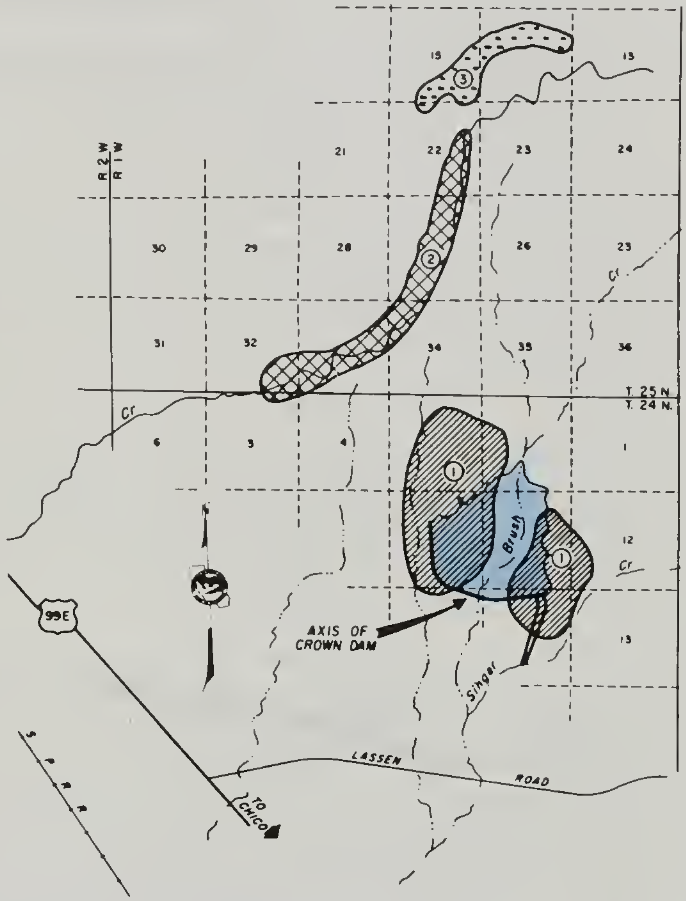
Qal — Recent alluvium. Deposits of unconsolidated silty, sandy gravel and cobbles.

Qfg — Pleistocene fan deposits. Fanglomerate member. Silty, sandy gravel; generally well cemented; locally contains thin sand and silt lenses.

Qfs — Silt member. Sandy silt to plastic silt; contains occasional thin sands and lenses; appears to underlie the fanglomerate along the proposed dam axis.

Tttb — Tuscan formation. Tuff breccia; andesite and basalt blocks to 10 feet in diameter in a crystal-lithic matrix; generally case-hardened; very little or no soil cover.

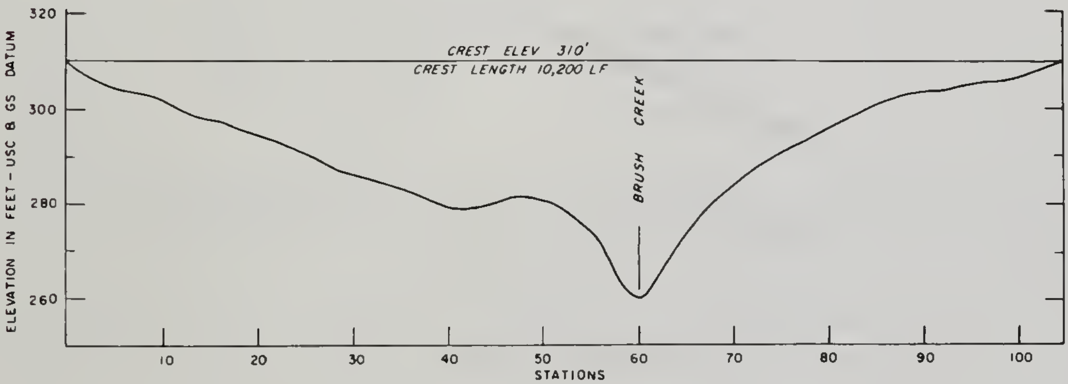
① ZONES 1 & 2 - FANGLOMERATE
② ZONES 3 & 4 - ALLUVIUM
③ BASALT (RIPRAP)



MATERIALS LOCATION AND VICINITY MAP

SCALE OF MILES

1 0 1 2 3 4



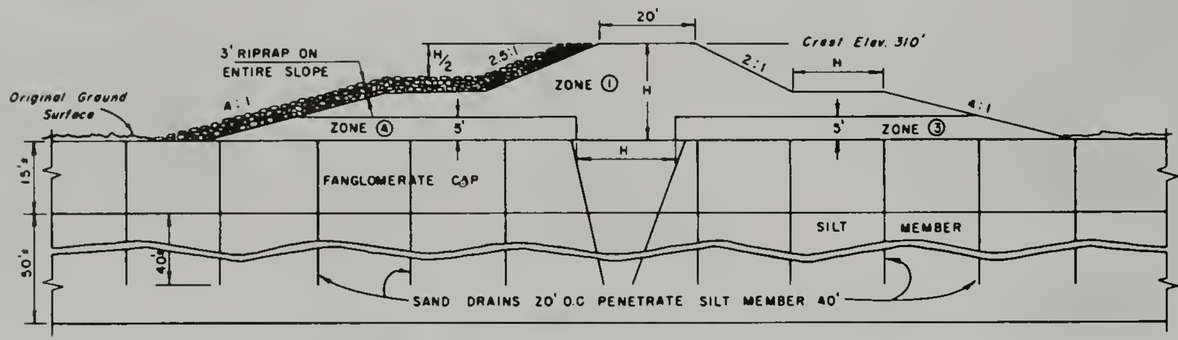
PROFILE ALONG AXIS OF DAM

LOOKING UPSTREAM

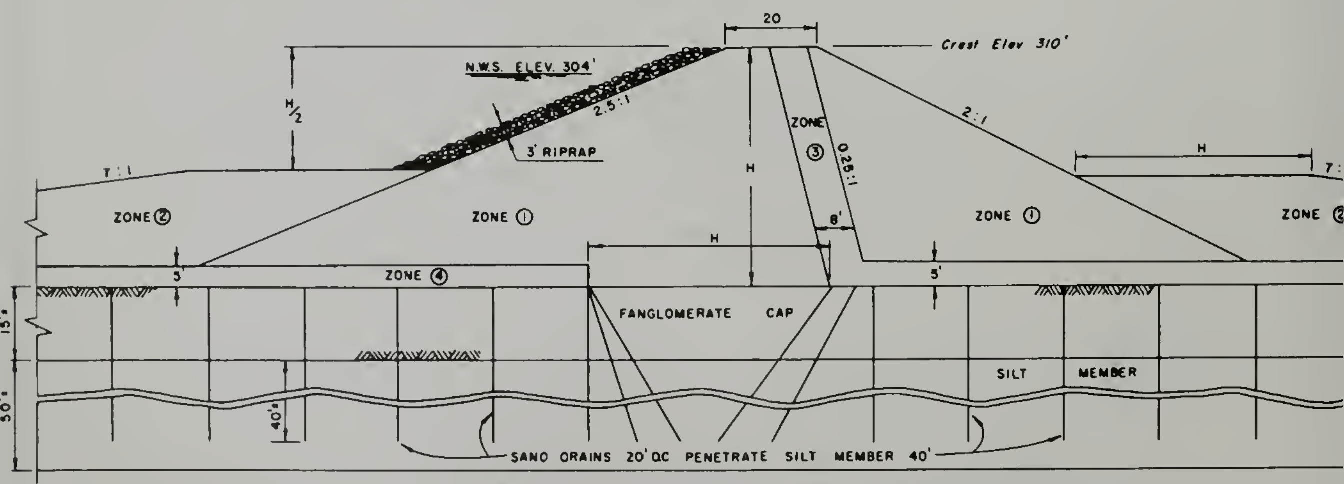
VERTICAL EXAGGERATION = 50.1

the blanket under the upstream section of the dam, would consist of pit run sand and gravel. Zones 3 and 4 material would be obtained from borrow area 2 along the Deer Creek channel. Riprap for the upstream slope of the dam could be obtained from the basalt in borrow area 3, located six miles north of the damsite. Total embankment volume would be 1,300,000 cubic yards.

Since the fanglomerate cap in the foundation would confine the underlying silt member and prevent it from draining and consolidating, it would be necessary to put sand drains down through the fanglomerate and into the silt to allow it to drain. The sand drains would consist of about 12-inch holes drilled to an average depth of 55 feet and filled with graded filter sand. Zones 3 and 4 would provide an exit path for the drains. Stripping would be limited to an average depth of one foot under the entire dam area. Typical dam sections for Crown Dam are shown in the following diagrams.



FOR DAM LESS THAN 25' IN HEIGHT ABOVE ORIGINAL GROUND



FOR DAM OVER 25' IN HEIGHT ABOVE ORIGINAL GROUND

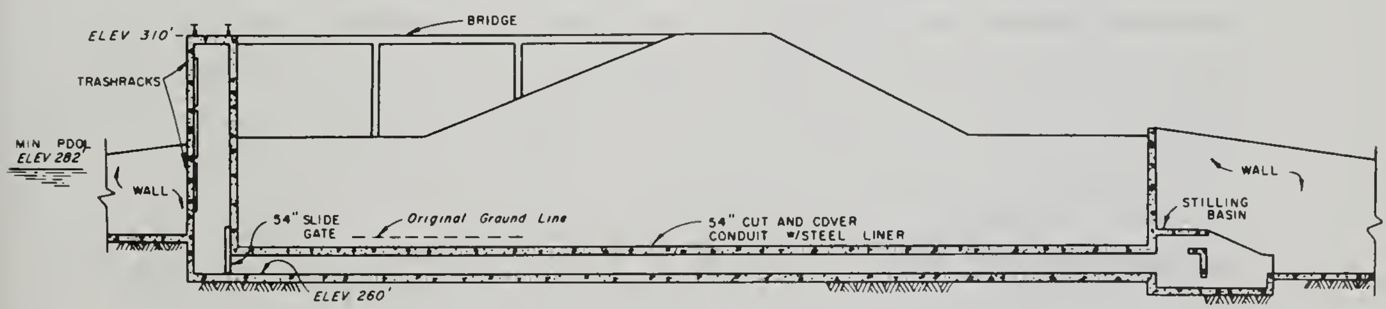
TYPICAL DAM SECTIONS

SCALE OF FEET
20 10 0 20 40

About three miles of road would be constructed to provide access to both ends of the Crown Dam axis, and a light duty road would be constructed along the southern edge of the dam.

Crown Spillway. An uncontrolled overflow, chute-type spillway would be located near the left end of the dam. It would consist of a 300-foot-long crest, and approach apron extending 100 feet upstream, and a 100-foot-long lined chute discharging into an excavated, unlined channel to Singer Creek. The 9,600-cfs maximum inflow of the probable maximum flood could be passed with a maximum outflow of 8,600 cfs and a surcharge of 4 feet. This would provide two feet of freeboard at the maximum discharge.

Crown Outlet Works. The outlet works would release water to the Vina Canal for irrigation use and for fish flow maintenance in lower Deer Creek. The 4.5-foot cut-and-cover conduit is designed for a capacity of 350 cfs at the minimum pool elevation of 282 feet. Since the outlet works would be near the highest part of the dam, an extensive system of retaining walls would be used at each end to reduce the length of the conduit. A concrete intake tower, about 50 feet high, would be installed on the upstream end of the conduit. Flows would be regulated by a slide gate at the conduit entrance, and other slide gates in the tower would permit selection of the reservoir level from which water would be drawn. The diagram below shows a profile of the outlet works.



PROFILE OF OUTLET WORKS

Vina Canal. This canal, with a capacity of 190 cubic feet per second, would carry water from Crown Reservoir back to Deer Creek at the existing Stanford-Vina Diversion Dam. It would terminate at Deer Creek in Section 1, T24N, R2W, Mount Diablo Base and Meridian. The canal would be concrete lined, of trapezoidal cross section, and would be 3.6 miles in length.

Recreation Facilities. There are several locations that are suitable for the development of recreation facilities at Deer Creek Meadows Reservoir. The initial recreation development is planned for the southern portion of the reservoir on the eastern and western shores. Supplemental future facilities are planned on the peninsular area in the northwestern portion of the reservoir. The variety of vegetative cover, including newly logged areas, dense brush, dense second growth coniferous forests, and mature open timber, is conducive to the establishment of various recreation use areas with natural buffer zones. The recreation facilities would be sized to accommodate about 450,000 visitor-days per year initially and about 1,300,000 visitor-days by the end of the period of analysis.

Crown Reservoir would require only a minimal amount of recreation facilities. These facilities would be sized to accommodate about 22,000 visitor-days per year initially and about 200,000 visitor-days by the end of the period of analysis.

Fishery Preservation and Enhancement. There are several specific features included in the Mill-Deer Project for fishery preservation and enhancement. Minimum pools were established at Crown and Deer Creek Meadows to ensure the maintenance of a reservoir fishery. A multiple-level outlet structure is planned at Deer Creek Meadows to provide suitable temperatures of downstream releases. The Childs Meadows Conduit will include a turnout to Gurnsey Creek to provide enhancement flows for trout spawning. This conduit will be screened at both ends. Fish passage facilities will be improved at the Stanford-Vina Diversion Dam and will be included at the Ishi Diversion Dam. The Yahi Canal would be designed to serve as a water transport facility and as an artificial spawning channel for fall-run salmon. Shortly after completion Crown Reservoir would be stocked with warmwater game fish. Easements would be acquired along lower Deer Creek to protect the existing spawning gravels and to ensure the integrity of the Mill-Deer Project operation plan.

Wildlife Preservation. Deer Creek Meadows Reservoir will inundate or otherwise destroy about 3,100 acres of wildlife habitat. Of this habitat, 680 acres are meadowland that are particularly valuable for deer fawning. Seasonal deer use of this land is estimated at 60 deer per square mile on the meadowland and 30 deer per square mile on the other lands. Other forms of wildlife use the area -- Canada Geese, ducks, and shorebirds are prevalent during the spring and summer months. Mitigation will be required for the loss of the 680 acres of meadowland. This could be accomplished by purchasing and managing 680 acres of suitable riparian timbered lands in the Childs Meadows, Los Creek, or Upper Feather River area. Management will consist of clearing, fencing, watering, and planting.

There is some waterfowl use in the Crown Reservoir area. Adoption of zoned recreation use and seeding of desirable plant species would result in a net increase of waterfowl use in this area.

It is estimated that more than 10,000 migrating deer cross the proposed Childs Meadows conduit alignment each fall and spring. Use of a buried pipe for this conduit would prevent disruption of this migration and consequential losses to this great deer herd.

Summary of Project Costs. A summary of the estimated project costs during the 100-year period of analysis is presented in Table 8. The initial capital outlay for this project is estimated to be $30,400,000. The present worth of the total expenditures during the 100-year period of analysis is estimated at $44,600,000. The average annual equivalent cost would be $1,820,000.

Project Accomplishments and Benefits

This multiple-purpose project would produce 20,000 acre-feet per year of new water for local irrigation and 18,000 acre-feet per year of new yield at the Sacramento-San Joaquin Delta. It would increase salmon and steelhead runs by about 18,000 fish per year, and would ultimately provide for about 1,500,000 visitor-days of fishing and other types of water-associated recreation use per year. It would also cause minor reductions in the frequency of flooding along Mill and Deer Creeks and along the Sacramento River.

TABLE 8
SUMMARY OF MILL-DEER PROJECT COSTS

Project Feature	Present Worth: Capital Cost	Present Worth: Operation Maintenance, Replacement, and General Expense	Present Worth: Total	Average Annual Equivalent Cost
Morgan Springs Diversion, Childs Meadows Conduit, and Appurtenances	$ 3,880,000	$ 20,000	$ 3,900,000	$ 159,000
Deer Creek Meadows Dam, Reservoir and Appurtenances	14,450,000	650,000	15,100,000	616,000
Recreation Facilities	4,400,000	11,900,000*	16,300,000	665,000
Ishi Diversion Yahi Canal**	950,000	550,000	1,500,000	61,000
Crown Dam, Reservoir and Appurtenances	5,410,000	90,000	5,500,000	225,000
Recreation Facilities	100,000	600,000*	700,000	29,000
Vina Canal, Primary Irrigation Distribution System, and Appurtenances	1,210,000	390,000	1,600,000	65,000
Total	$30,400,000	$14,200,000	$44,600,000	$1,820,000

*Includes present worth value of future additions.
**Including artificial spawning facilities.

The project would be operated in the following manner. Excess winter and spring flows of Mill Creek would be diverted into Deer Creek Meadows Reservoir from the Morgan Springs Diversion Dam, via the Childs Meadows Conduit. These flows, in addition to the natural flows of Deer Creek, would be stored in Deer Creek Meadows Reservoir. Deer Creek Meadows Reservoir would be operated to provide enhancement to recreation at the reservoir, fisheries enhancement (trout, steelhead, and salmon) in Deer Creek below the dam, and new irrigation water supplies on the valley floor. Crown Reservoir, an offstream storage reservoir on Brush Creek on the valley floor, would be constructed to supplement the water supply developed at Deer Creek Meadows Reservoir and to produce additional water-associated recreation benefits. Excess flows of Deer Creek would be diverted into Crown Reservoir from the Ishi Diversion Dam, via the Yahi Conduit. This water, in addition to natural inflow from Brush Creek, would be stored during high runoff periods and released back into Deer Creek during water-deficient months to provide attraction and spawning flows for steelhead and salmon. Stored water would also be released to supply new water to local agricultural lands.

Recreation. Deer Creek Meadows Reservoir would provide an extremely attractive recreation area. Accessibility would be excellent, since State Highways 32 and 36 intersect in the proposed reservoir area. Water-associated recreation in the form of camping, boating, picnicking, fishing, and swimming would be provided. With adequate facilities provided for the predicted demand, it is estimated that there will be 250,000 visitor-days of use annually at the beginning of project operation, and about 1,300,000 visitor-days of use annually by the end of the period of analysis.

Crown Reservoir would provide a poor recreation environment due to extreme reservoir fluctuations and barren lands surrounding the reservoir. With adequate facilities provided for the predicted demand, it is estimated that there will be 12,000 visitor-days of use annually at the beginning of project operation, and about 200,000 visitor-days of use annually by the end of the period of analysis.

Seventy percent of the use projected for these two reservoirs would be non-fishing oriented and would have a capitalized value of $23,800,000.

Fishery Enhancement. The Mill-Deer project would create several different fishery benefits: (1) a trout fishery at Deer Creek Meadows Reservoir, (2) a warmwater fishery at Crown Reservoir, (3) enhancement of the trout fishery downstream from Deer Creek Meadows Reservoir, (4) enhancement of the steelhead run in Deer Creek (500 fish annual increase), (5) enhancement of spring-run king salmon in Deer Creek

(4000 fish annual increase), and (6) enhancement of fall-run king salmon in the Yahi spawning channel (13,500 fish annual increase). The combined capitalized value of all these benefits would be $18,400,000.

Conservation Yield. The Mill-Deer Project would yield 20,000 acre-feet per year on a local agricultural demand schedule. No specific service area was defined for this yield. However, based on crop projections and future water requirements in the east side valley floor area (see Chapter 3), this yield could be expected to have a unit benefit value of $15 per acre-foot per year. Assuming a 10-year uniform demand buildup and a 10 percent loss in distribution, this yield would have a capitalized value of $5,500,000.

In making releases for fishery enhancement, the Mill-Deer Project would create a new water supply in the Sacramento-San Joaquin Delta. Water which previously would have reached the Delta during periods of spill would now be conserved and released during periods of need. It is estimated that this increased yield would be about 18,000 acre-feet per year. Assuming a 1970 construction date, but no demand in the Delta until 1990, this yield would have a capitalized value of $5,900,000.

Flood Control. The only flood control benefit attained by the Mill-Deer Project would result from minor reductions in flood frequencies along the Sacramento River and in the Butte Basin. As explained earlier in this chapter, this benefit would have an annual unit value of 50¢ per acre-foot of live storage. The capitalized value of this benefit for the 120,000 acre-feet of live storage in Deer Creek Meadows and Crown Reservoir would be $1,500,000.

Summary of Project Benefits. A summary of the estimated benefits is presented in Table 9. The present worth value of the total benefits is $55,100,000; the average annual equivalent value is $2,250,000.

Economic Justification

The present worth of project benefits throughout the period of economic analysis (1970-2070) was estimated at $55,100,000. The total capitalized cost of the project, including the present worth of all future expenditures, was estimated at $44,600,000. The resultant benefit-cost ratio is 1.23:1. The Mill-Deer Project is economically justified and, if constructed in 1970, would produce net benefits (benefits minus costs) of about $10,500,000.

TABLE 9

SUMMARY OF MILL-DEER PROJECT BENEFITS

Project Purposes	Capitalized Benefits	Average Annual Equivalent Benefits
Recreation	$23,800,000	$ 975,000
Fishery Enhancement	18,400,000	750,000
Local Irrigation Yield	5,500,000	225,000
Export Yield	5,900,000	240,000
Flood Control	1,500,000	60,000
Total	$55,100,000	$2,250,000

Cost Allocation

A preliminary allocation of project costs was made to determine the amount of the total project costs that would be charged to each of the project purposes. A summary of the results of the allocation is presented in Table 10.

This allocation shows that the annual cost of providing 18,000 acre-feet of annual yield to the Delta would be $124,000. Since it was assumed that water would not be needed for the first twenty years of the repayment period, the cost per acre-foot of yield would be $15.60.

The annual cost ($96,000) of supplying 20,000 acre-feet per year of local agricultural water supply would result in a water cost of $5.70 per acre-foot.

TABLE 10

PRELIMINARY COST ALLOCATION FOR

THE MILL-DEER PROJECT

(In average annual equivalent dollars)

	Recreation	Fishery Enhancement	Local Water Supply	Delta Water Supply	Flood Control	Total
Benefits	975,000	750,000	225,000	240,000	60,000	2,250,000
Alternative Costs	953,000	1,009,000	101,000	145,000	1/	
Total Justifiable Costs	953,000	750,000	101,000	145,000	60,000	2,009,000
Separable Costs	344,000	300,000	70,000	0 3/	0	714,000
Remaining Justifiable Expense	609,000	450,000	31,000	145,000	60,000	1,295,000
Percent Distribution	47.0%	34.8%	2.4%	11.2%	4.6%	100.0%
Remaining Joint Costs 2/	520,000	385,000	26,000	124,000	51,000	1,106,000
Total Allocated Costs	864,000	685,000	96,000	124,000	51,000	1,820,000

1/ Assumed to be in excess of benefits.
2/ Remaining joint costs are allocated in accordance with the percentage distribution of remaining justifiable expenses.
3/ Since the yield to the Delta results from the fishery enhancement releases, there is no separable cost to Delta water supply. However, if fishery enhancement was not a project purpose there would be some separate cost to Delta water supply if the yield were to be maintained.

Possible Future Additions

There are two possible additions to the Mill-Deer Project that could be constructed at any future date, if justified.

Sugarloaf Reservoir and a series of conduits and powerhouses (see Figure 2) would add hydroelectric energy generation as a project purpose. Current studies indicate that this addition is not economically justified. However, if the value of power increased substantially, these features could be easily added to the Mill-Deer Project. If these features were added, great care should be taken in protecting the valuable fishery enhancement attained by the project as proposed in this report.

The second possible future addition would be the enlargement of Crown Reservoir (see Figure 2 - Brush Basin Reservoir). Storage at this site is very costly and much higher unit benefits for water supply would be needed to support this addition.

Wing Project

The Wing Project (Figure 6), located in Tehama County, would consist of a dam and reservoir on Inks Creek, a diversion dam and conduit to deliver surplus waters from Paynes Creek to the Inks Creek drainage, and water-associated recreation facilities. As analyzed in this report, this project would be operated for recreation and yield to the Sacramento-San Joaquin Delta.

Hydrology

The drainage area tributary to Wing damsite is about 23 square miles, and the drainage area tributary to the Paynes Creek diversion is about 69 square miles. Monthly flows for the forty-year period from October 1, 1921, through September 30, 1961, were computed at Wing damsite and at the Paynes Creek diversion site. Mean annual runoff for this period was 9,000 acre-feet at Wing damsite and 40,000 acre-feet at the Paynes Creek diversion site.

A probable maximum flood hydrograph with a peak discharge of 13,000 cubic feet per second was computed for Inks Creek at Wing damsite.

Foundation Geology and Construction Materials

The reservoir area appears to be underlain by conglomerate with basalt caps appearing at irregular intervals. The spillway site is on a basalt cap which would permit the use of an unlined spillway.

Construction material for the earth and rockfill dam is available near the site. Impervious material would come from the reservoir area, with about a one-mile haul. Rock could be quarried from near the right abutment. Deposits of sandy gravel for the transition zone are available downstream from the damsite.

Project Features - Designs and Costs

The following paragraphs describe the features of the Wing Project and summarize the project costs. The project location is shown on Figure 6 and statistics for the project features are presented in Table 11.

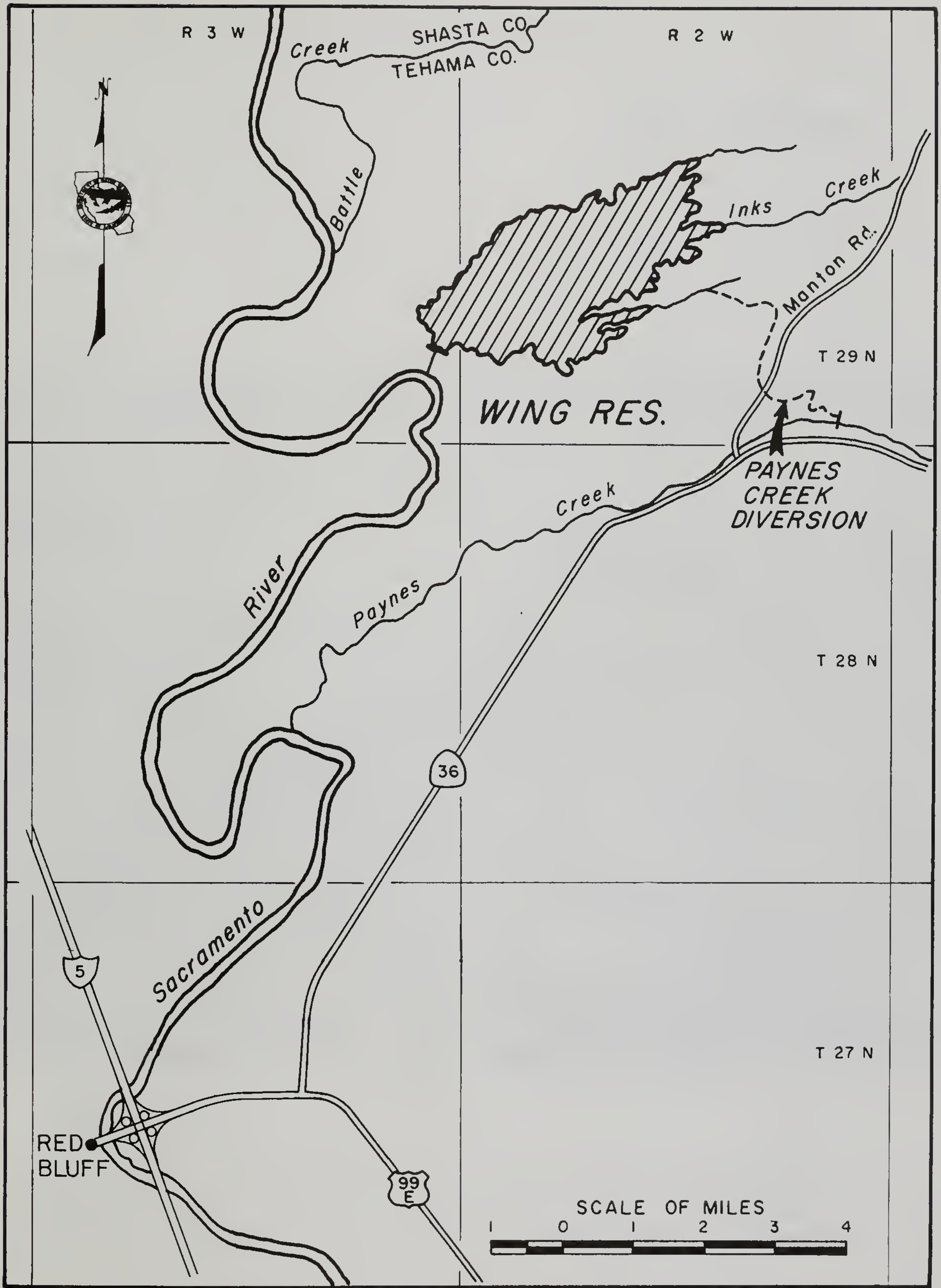


Figure 6. Wing Project Location Map

TABLE 11

WING PROJECT FEATURES

PRIMARY PROJECT PURPOSES

Export yield and recreation

WING RESERVOIR

Drainage area, in square miles	23
Maximum water surface elevation, in feet	508
Normal water surface elevation, in feet	500
Minimum pool elevation, in feet	360
Capacity, at normal pool elevation, in acre-feet	244,000
Area of water surface at normal pool, in acres	3,750

DAM

Location	Sec 25, T29N, R3W, MDB&M
Type	Central core rockfill
Height above streambed, in feet	192
Crest elevation, in feet	510
Volume of fill, in cubic yards	3,300,000

SPILLWAY

Type	Ungated chute
Design capacity, in second-feet	14,000
Elevation of weir crest, in feet	500
Length of weir crest, in feet	180

OUTLET WORKS

Conduit type	Cut and cover
Conduit size	36"
Control type	Howell-Bunger valve
Control size	24"
Design capacity, in cubic feet per second	100

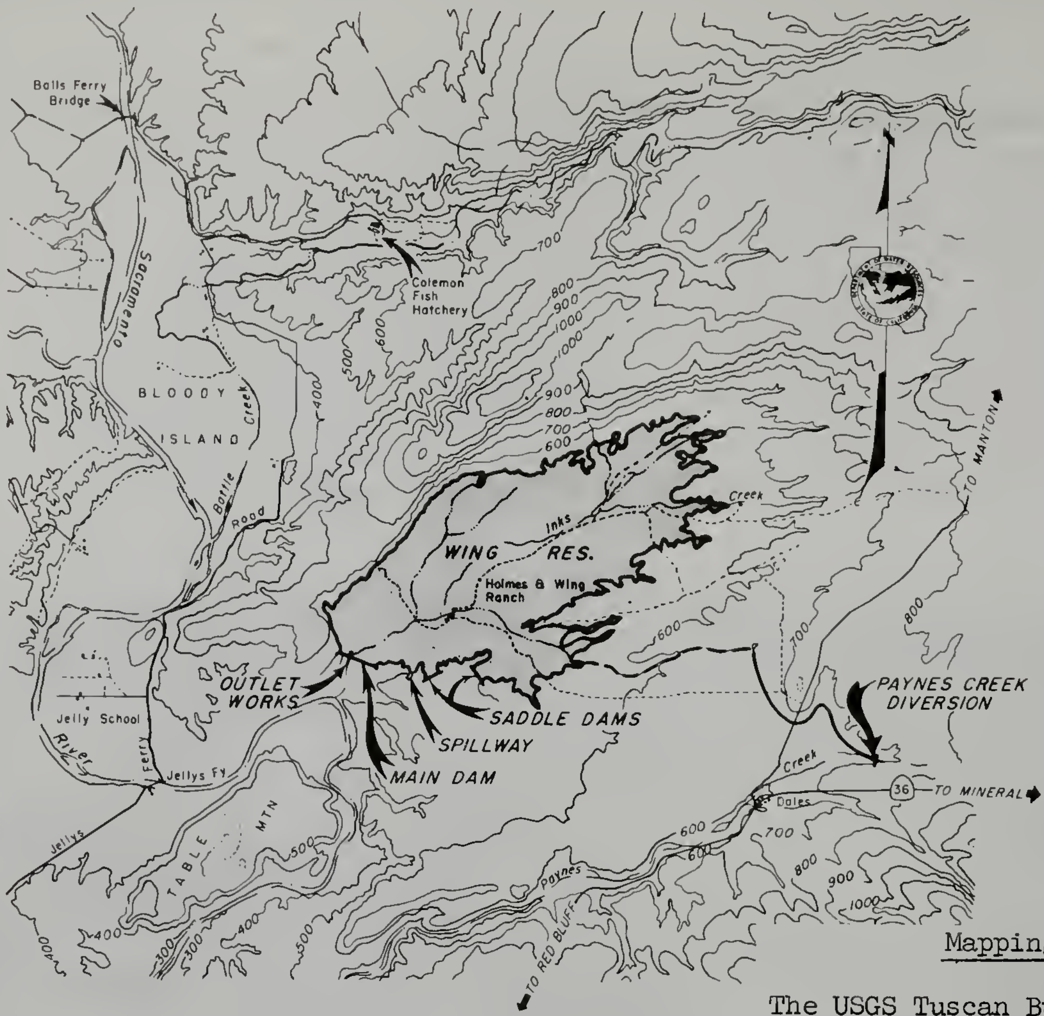
PAYNES CREEK DIVERSION

Type	
Dam	Concrete gravity
Conduit	Trapezoidal canal, concrete lined
Location	
Dam	Sections 35 and 36, T29N, R2W, MDB&M
Conduit	Paynes Creek to Inks Creek
Size or capacity	
Dam height, in feet	10
Conduit, capacity in cfs	500

Wing Reservoir. The reservoir would have a normal water surface elevation of 500 feet, a gross storage capacity of 244,000 acre-feet, and a water surface area of 3,750 acres. Approximately 5,400 acres of land would have to be acquired to provide for surcharge storage and water-associated recreation use. Clearing would involve the removal of scattered small trees between the minimum and maximum pool elevations. The aerial photograph below shows the approximate location of the Wing Reservoir water surface and dam. Figure 7 shows a layout of the Wing Project and presents area-capacity curves for Wing Reservoir.

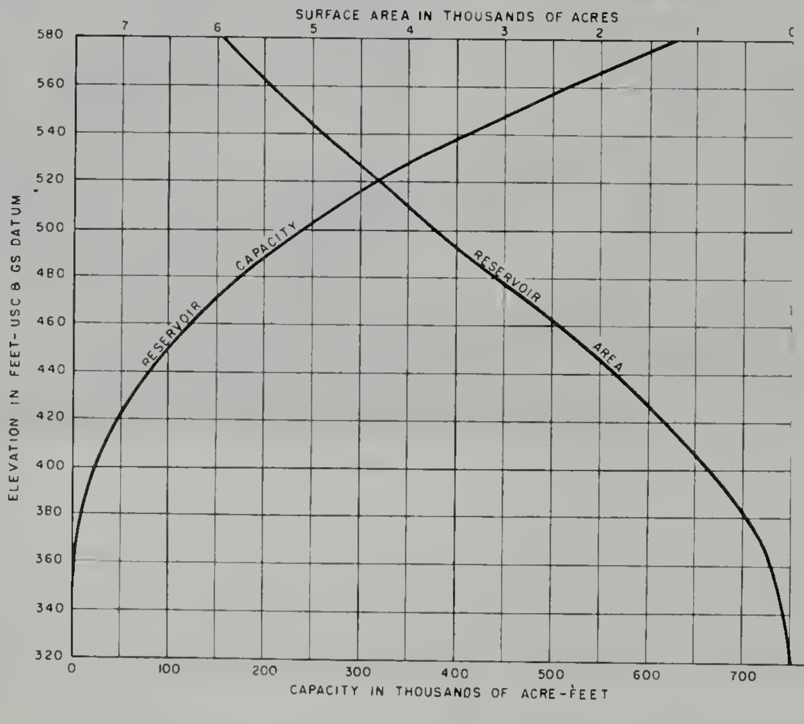
An artist's conception of Wing Reservoir on Inks Creek

Dam. A 192-foot-high dam with crest elevation at 510 feet was selected. The dam would consist of an impervious core and transition zones with 0.75:1 side slopes and rock at 2.5:1 slopes on the upstream



GENERAL PLAN

SCALE OF MILES



AREA-CAPACITY CURVES

Mapping

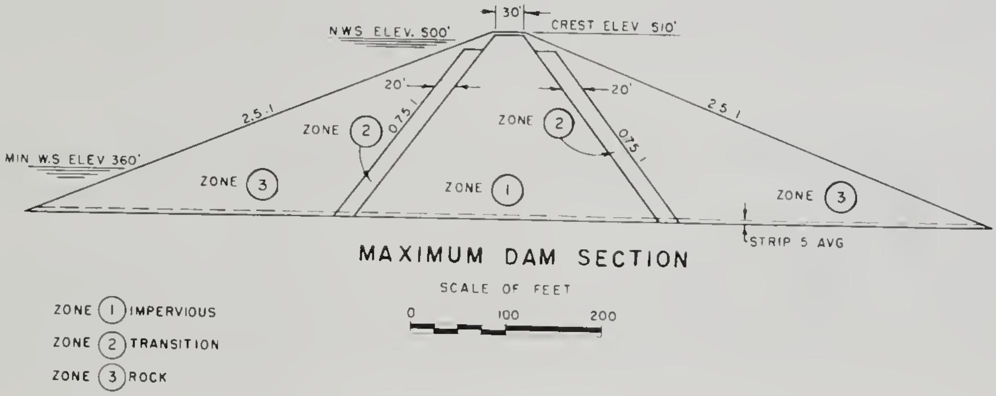
The USGS Tuscan Buttes 15-minute quadrangle of 1947 covers the Wing Reservoir area. A damsite map at a scale of 1" = 500' with 25-foot contours was used for all design and layout work.

Geologic Investigations

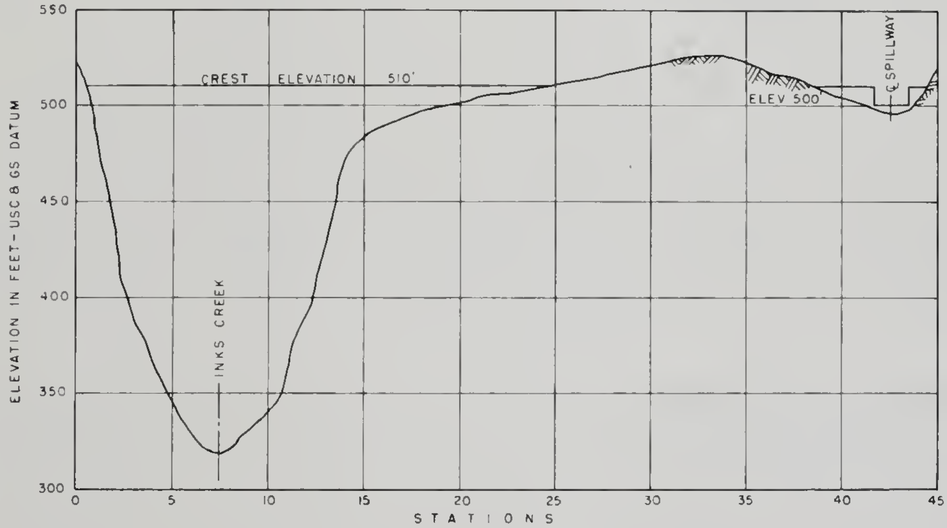
The designs and cost estimates for this project were based on very limited geologic information -- two cursory geologic examinations of the damsite by Department geologists in 1955 and 1965, and a geologic map of the upper Sacramento Valley, including the reservoir area, prepared by a major oil company.

Figure 7. Wing Project Layout

and downstream faces. The crest width would be 30 feet, and the total embankment required would be 3,300,000 cubic yards. The diagrams below show the maximum dam section and a profile along the dam axis.



MAXIMUM DAM SECTION



PROFILE ALONG AXIS OF DAM
LOOKING UPSTREAM
VERTICAL EXAGGERATION = 10:1

In addition to the main dam, two saddle dams would be located 1 and $1\frac{1}{2}$ miles east of the main dam. These dams would be random fill sections with 3:1 slopes upstream and downstream and a maximum height of 35 feet. The total embankment of the saddle dams would be 260,000 cubic yards.

Spillway. An ungated spillway would be located in a saddle one-half mile east of the left abutment. The 180-foot weir was designed to pass the 13,000-cfs probable maximum flood plus 1,000 cfs from the Paynes Creek diversion. The design was based on the assumption that the weir would be founded on a basalt cap and the spillway chute would be cut through the basalt and would not require lining. The chute would be 600 feet long and tapered to an end width of 100 feet. After leaving the chute, the water would flow into a natural gully and then into Inks Creek.

<u>Outlet Works</u>. The outlet works would be required to discharge 100 cfs at the minimum pool elevation of 360 feet. A steel-lined cut-and-cover conduit, regulated by a 24-inch Howell-Bunger valve, would be installed near the center of the dam. Guard service would be provided by a 36-inch-diameter, hydraulically operated slide gate on the intake tower.

<u>Paynes Creek Diversion</u>. A small gravity diversion dam to divert 500 cfs from Paynes Creek would be located along the section line dividing Sections 35 and 36, T29N, R2W. Water would enter the diversion canal at elevation 685 through a headworks assembly consisting of three manually operated slide gates. The trapezoidal canal would have a bottom width of 13 feet and a maximum depth of six feet. The canal would enter a natural gully leading into the reservoir in the SW$\frac{1}{4}$ of Section 23, T29N, R2W.

<u>Recreation Facilities</u>. There would be sufficient land suitable for development of recreation facilities on the southern shore of Wing Reservoir. This area is sparsely populated with oak trees and would require landscaping. The facilities would be sized to accommodate about 90,000 visitor-days per year initially and about 1,000,000 visitor-days by the end of the project repayment period. Facilities costs were based on Department of Parks and Recreation standards.

<u>Fishery Preservation and Enhancement</u>. There would be no specific costs for fishery preservation at this project. Specific costs for fishery enhancement would consist of an initial stocking of Wing Reservoir with warmwater game fish plus future costs of restocking whenever the reservoir was drawn down below 10,000 acre-feet of gross storage.

Preservation of Wildlife. Wing Reservoir would inundate 3,750 acres of rangeland and oak-covered bottom lands. Wildlife found in the area include deer, quail, doves, and rabbits. Although a few deer use the area, it is not considered critical deer winter range. Wildlife losses in this area would be limited and would be more than compensated for by enhancement of waterfowl through the creation of new habitat.

Summary of Project Costs. A summary of the estimated project costs during the 100-year period of analysis (1970-2070) is presented in Table 12. The initial capital outlay for this project is estimated to be $9,910,000. The present worth of the total expenditures during the 100-year period of analysis is estimated at $14,210,000. The average annual equivalent cost would be $580,000.

TABLE 12

SUMMARY OF WING PROJECT COSTS

	Present Worth			
Project Features	Capital Cost	Operation, Maintenance, Replacement, and General Expense	Total	Average Annual Equivalent Cost
Wing Dam, Reservoir and Appurtenances	$9,180,000	$ 890,000	$10,070,000	$411,000
Recreation Facilities	730,000	3,410,000*	4,140,000	169,000
Total	$9,910,000	$4,300,000	$14,210,000	$580,000

*Includes present worth value of future additions.

Project Accomplishments and Benefits

Wing Reservoir would provide an excellent recreation area, a good warmwater fishery, and increased yield to the Sacramento-San Joaquin Delta. The operational plan for this reservoir would be a long-range conservation operation. No releases would be made during normal and above normal years. The reservoir would be drawn down only during critical dry cycles. During the historic operation period (1921-1961), serious drawdown would have occurred between 1927 and 1934 only. The accomplishments and benefits from each of the project purposes are discussed in the following paragraphs.

Recreation. The reservoir would be very near its normal pool approximately 80 percent of the time and would create a very desirable atmosphere for recreationists. With adequate facilities provided for the predicted demand, it is estimated that there will be about 65,000 visitor-days of use annually at the beginning of the project operation, and about 1,000,000 visitor-days of use annually by the end of the project repayment period. Eighty-five percent of this projected use would be non-fishing and would have a capitalized benefit value of $8,150,000.

Fishery Enhancement. The only fishery enhancement of this project would be the creation of a good warmwater fishery in Wing Reservoir. Fifteen percent of the total recreation use would be supported by this fishery and would create a fisheries enhancement benefit with a capitalized value of $1,450,000.

Conservation Yield. During a very dry cycle the entire storage of Wing Reservoir would be released into the Sacramento River to provide increased yield at the Sacramento-San Joaquin Delta. When operated through the historic six and one-half year critical period at the Delta, this project would yield 28,000 acre-feet per year. Assuming a 1970 construction date and no demand at the Delta until 1990, this yield would provide a conservation benefit with a capitalized value of $9,170,000.

Flood Control. The very small drainage area of Wing Reservoir (23 square miles) precluded any significant flood control benefits for this project. However, a later section in this chapter discusses the possible future addition of a Battle Creek Flood Diversion to this project.

Summary of Project Benefits. A summary of the estimated benefits for the Wing Project is presented in Table 13. The present worth value of the total benefits is $18,770,000; the average annual equivalent value is $766,000.

TABLE 13

SUMMARY OF WING PROJECT BENEFITS

Project Purposes	Capitalized Benefits	Average Annual Equivalent Benefits
Fishery Enhancement	$ 1,450,000	$ 59,000
Recreation	8,150,000	333,000
Delta Water Supply	9,170,000	374,000
Total	$18,770,000	$766,000

Economic Justification

The present worth of project benefits throughout the 100-year period of analysis (1970-2070) was estimated to be $18,770,000. The total capitalized cost of the project, including the present worth of all future expenditures, was estimated to be $14,210,000. The resultant benefit-cost ratio is 1.32:1. The Wing Project is economically justified and if constructed in 1970 would produce net benefits (benefits minus costs) of about $4,560,000.

Cost Allocation

A preliminary allocation of project costs was made to determine the amount of the total project costs that would be charged to each of the project purposes. A summary of the results of the allocation is presented in Table 14.

This allocation shows that the annual cost of providing 28,000 acre-feet of annual yield to the Delta would be $217,000. Since it was assumed that water would not be needed for the first twenty years of the repayment period, the cost per acre-foot of yield would be $17.40.

Possible Alternatives and Future Additions

As previously stated, Wing Reservoir is the only good reservoir site in the Inks and Paynes Creek drainage basins.

There is one possible future addition to this project that may become economically justified at a later date. It would be physically

TABLE 14

PRELIMINARY COST ALLOCATION FOR

THE WING PROJECT

(In average annual equivalent dollars)

	Fishery Enhancement	Recreation	Delta Water Supply	Total
Benefits	$59,000	$333,000	$374,000	$766,000
Alternative Costs	1/	1/	222,000	
Total Justifiable Costs	59,000	333,000	222,000	614,000
Separable Costs	1,000	169,000	185,000	355,000
Remaining Justifiable Expense	58,000	164,000	37,000	259,000
Percent Distribution	22.4%	63.3%	14.3%	100.0%
Remaining Joint Costs 2/	50,000	143,000	32,000	225,000
Total Allocated Costs	$51,000	$312,000	$217,000	$580,000

1/Assumed to be in excess of benefits.

2/Remaining joint costs are allocated in accordance with the percentage distribution of remaining justifiable expense.

feasible to divert flood flows from Battle Creek into Wing Reservoir. While this diversion would be very costly, it would provide flood protection along lower Battle Creek and might significantly increase the yield of Wing Reservoir. If more advanced studies of the Wing Project are conducted, this possibility should definitely be evaluated.

Jonesville Project

The Jonesville Project would be located in Butte County and would consist of a dam and reservoir on upper Butte Creek and a series of gravity diversion dams and conduits to deliver domestic water supplies to the Cohasset, Forest Ranch, and Magalia-Paradise Ridges. This project was formulated to provide these local domestic water supplies and water-associated recreation opportunities.

Hydrology

The drainage area of the Jonesville damsite is about 30 square miles. Monthly flows for the period October 1, 1921, through September 30, 1961, were computed at the damsite. Mean annual runoff during this period was 59,000 acre-feet. Operation studies of the reservoir took into consideration existing downstream water rights and streamflow accretion between the reservoir and the diversions to the project service areas.

A probable maximum flood hydrograph was computed for the area tributary to Jonesville Reservoir. The probable maximum peak inflow to the reservoir was estimated at 25,000 cfs.

Foundation Geology and Construction Materials

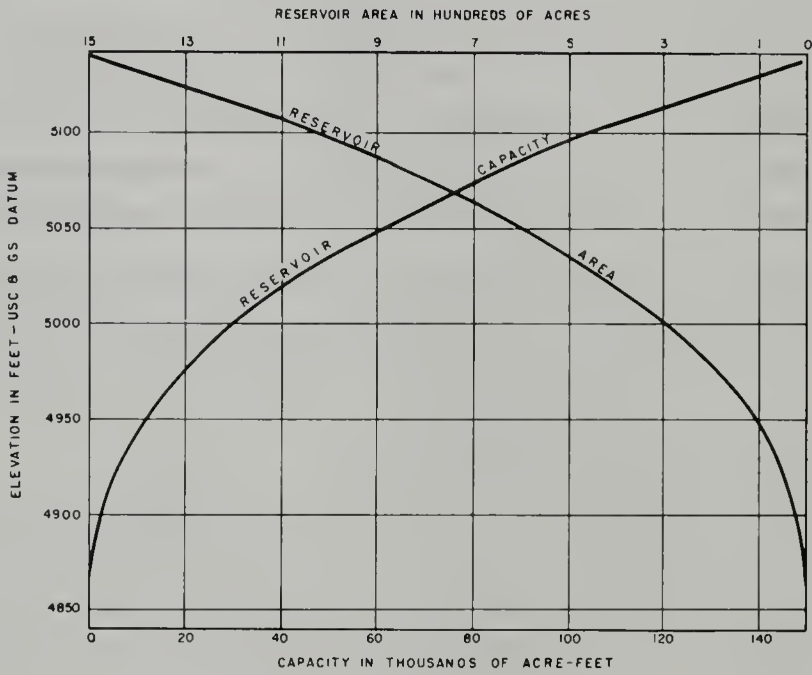
Cursory field investigation indicated that the right side of the dam would be founded on tuff breccia overlain by a basalt flow. The stream channel and left abutment contain mostly stream sediments and some volcanic rocks. It was assumed that these materials would provide an adequate foundation for the dam provided they were properly treated.

The reservoir would be located in volcanic rocks and tertiary stream deposits where the possibility of leakage exists. Material suitable for semi-pervious fill, made up of alluvium, glacial debris, and channel deposits, is plentiful within the reservoir area--about a half mile east of the damsite. Quarried volcanic bedrock, obtained from a quarry located on top of the right abutment, would make up the riprap and rockfill for the upstream face of the dam. Relatively impervious fill for the random zone is available from areas of decomposed volcanic rocks adjacent to the project area.

Project Features - Designs and Cost Estimates

This section describes the features of the Jonesville Project and summarizes the project costs. The project location is shown on Figure 8, the project layout is shown on Figure 9, and statistics for the project features are presented in Table 15.

Reservoir. Jonesville Reservoir would have a normal water surface elevation of 5027 feet, a gross storage capacity of 46,000 acre-feet, and a water surface area at normal pool of 450 acres. Reservoir capacity and surface area at various water surface elevations are indicated in the following diagram.



AREA-CAPACITY CURVES

Four hundred and eighty acres of land would be acquired for the reservoir and adjacent areas suitable for recreation development. According to plans, clearing cost would be reduced by timber salvage within the reservoir area. About six miles of paved, two-lane road would be relocated around the north end of the reservoir. Three small, low-cost bridges would also be required. The photograph on page 86 has the approximate dam location and normal water surface sketched on it.

Dam. The dam section would have a 30-foot crest width and a length of 1,290 feet. The upstream face would slope 3:1 above elevation 4930 and 4:1 below that elevation with a 30-foot-wide berm at the break

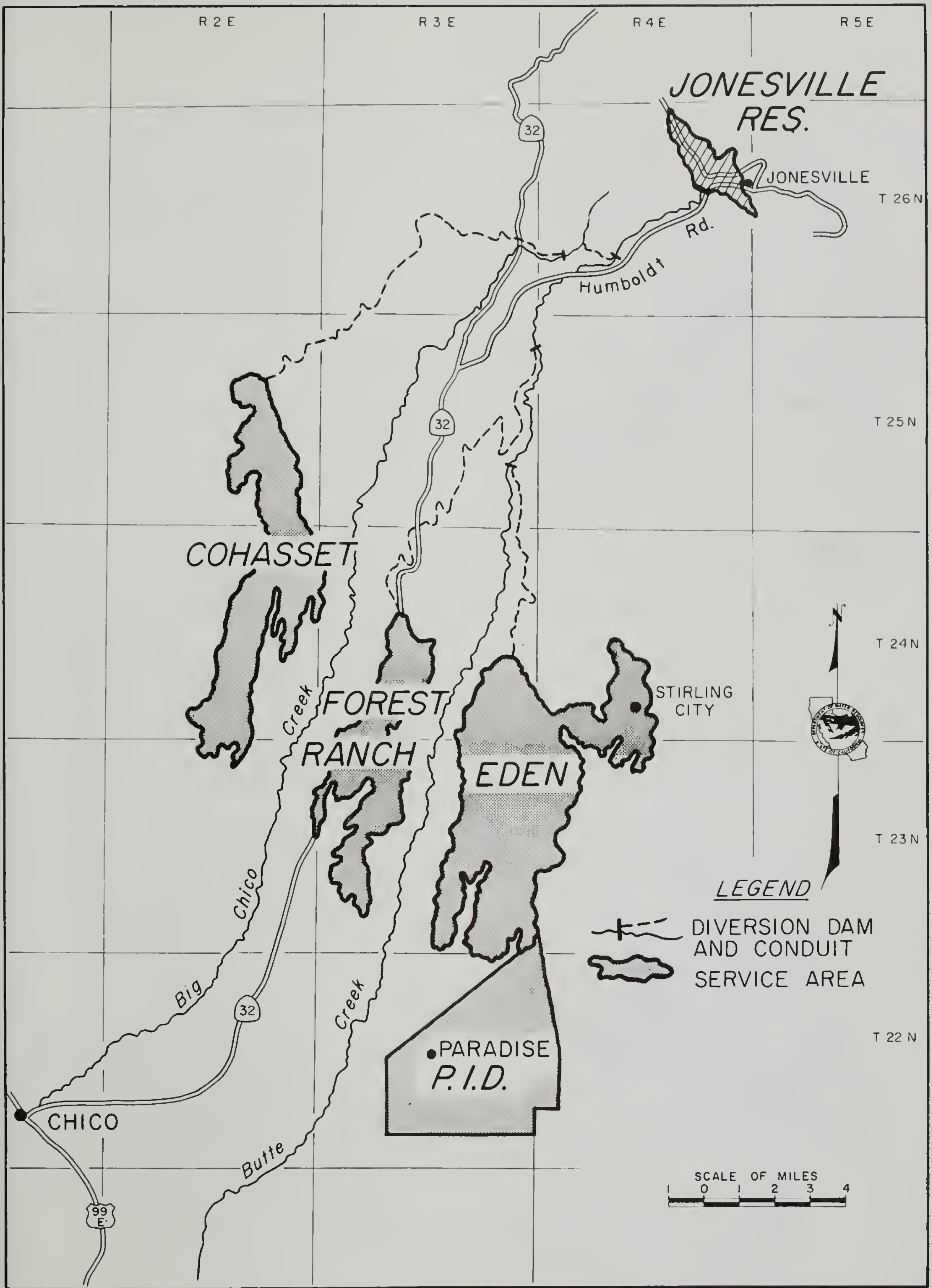
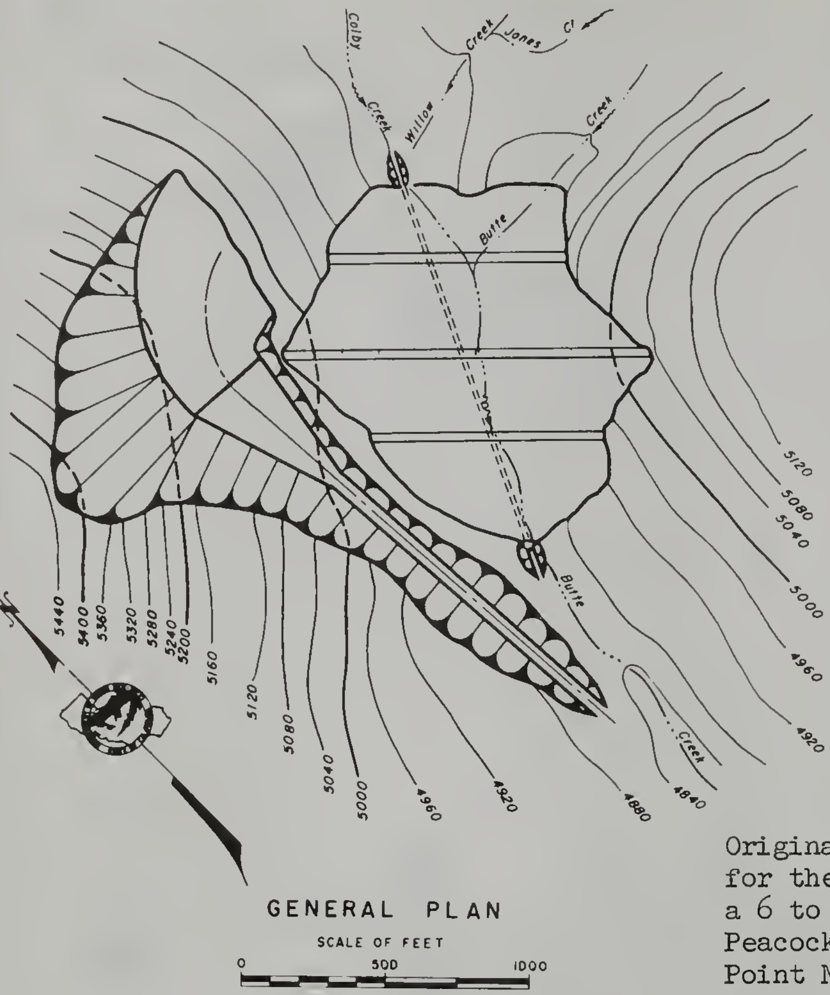
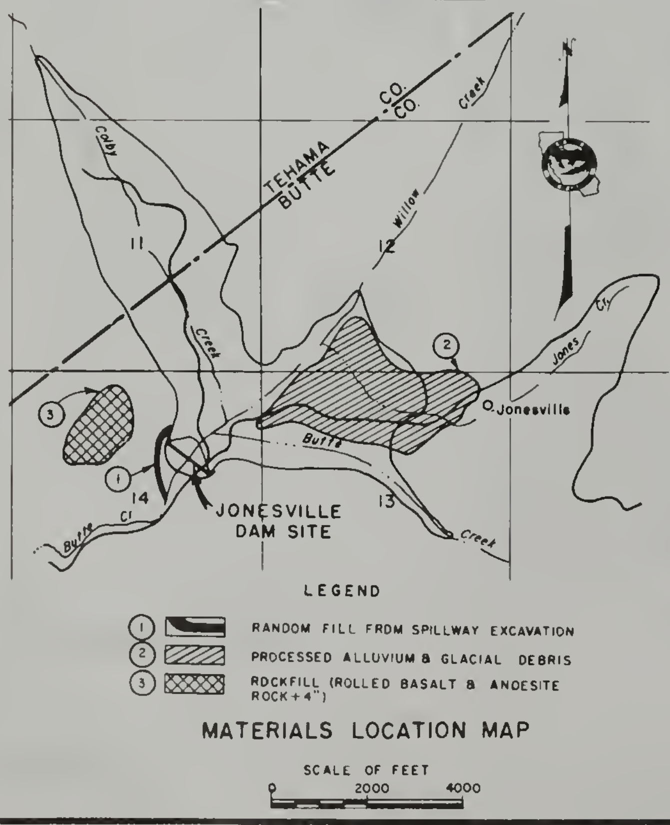


Figure 8. Jonesville Project Location Map





Mapping

Original layout and design work for the project was performed on a 6 to 1 enlargement of the Peacock Point S.W. and Peacock Point N.W. quadrangles. The originals were $7\frac{1}{2}$-minute quads with 40-foot contour intervals.

In 1965, a photogrammetric map of the Jonesville Dam and Reservoir site was prepared by the Department. This map, at a scale of 1" = 300', was used to refine the original project design.

Geology

A geological reconnaissance of the proposed dam and reservoir was made by Department geologists in September 1964. Regional geology for this area was taken from the "Westwood Sheet" (scale 1:25,000), California Division of Mines. No subsurface explorations were conducted.

Figure 9. Jonesville Project Layout

TABLE 15

JONESVILLE PROJECT FEATURES

PRIMARY PROJECT PURPOSES

Local Domestic Water Supply and Recreation

JONESVILLE RESERVOIR

Drainage area, in square miles	30
Maximum water surface elevation, in feet	5,034
Normal water surface elevation, in feet	5,027
Minimum pool elevation, in feet	4,930
Capacity, at normal pool elevation, in acre-feet	46,000
Area of water surface at normal pool, in acres	450

DAM

Location	Section 14, T26N, R4E, MDB&M
Type	Zoned earthfill
Height above streambed, in feet	178
Crest elevation, in feet	5,038
Volume of fill, in cubic yards	2,900,000

SPILLWAY

Type	Ungated chute
Design capacity, in second-feet	25,000
Elevation of weir crest, in feet	5,027
Length of weir crest, in feet	300

OUTLET WORKS

Conduit type	Cut and cover
Conduit size	36"
Control type	Howell-Bunger
Control size	24"
Energy dissipator	Stilling basin
Design capacity, in cubic feet per second	140

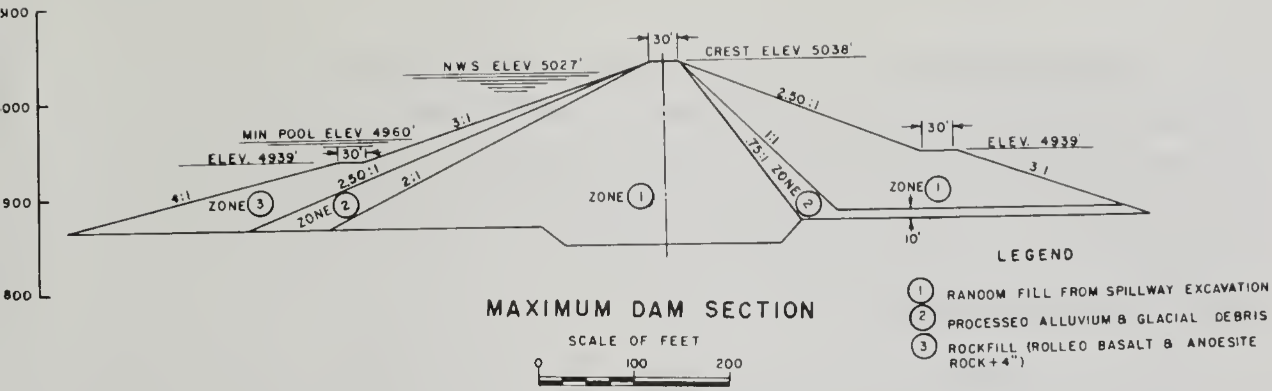
PRIMARY DISTRIBUTION

Cohasset Ridge conduit	Butte Cr. Mdws. to Cohasset, 11 cfs
Forest Ranch conduit	Butte Cr. to Forest Ranch, 10 cfs
Magalia-Paradise conduit	Butte Cr. to Eden Service Area and Paradise Irrigation District, 112 cfs

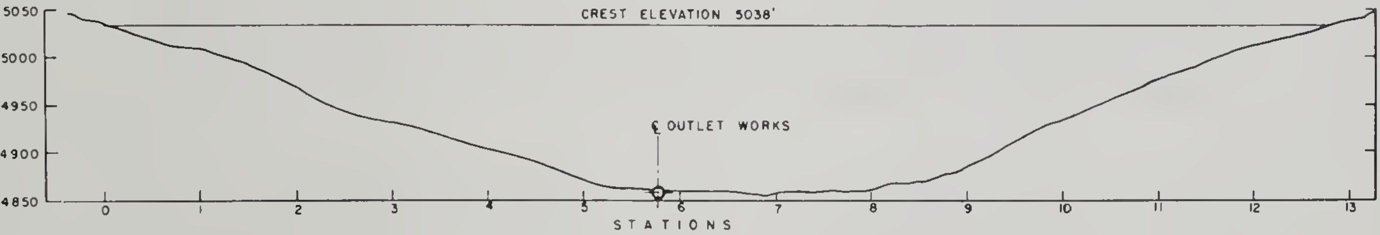
An artist's conception of Jonesville Reservoir on Butte Creek

in slope. The downstream face also would have a 30-foot berm at elevation 4930 with slope above at $2\frac{1}{2}$:1 and slope below at 3:1.

The dam would be basically a random fill, with control of the line of saturation provided by a downstream sloping zone of processed alluvium. Stability of the upstream face would be insured by providing a quarried rock shell. A transition zone of processed alluvium and glacial debris would be placed between the random zone and the rolled rock zone. The following diagrams show the maximum dam section and a profile along the dam axis.



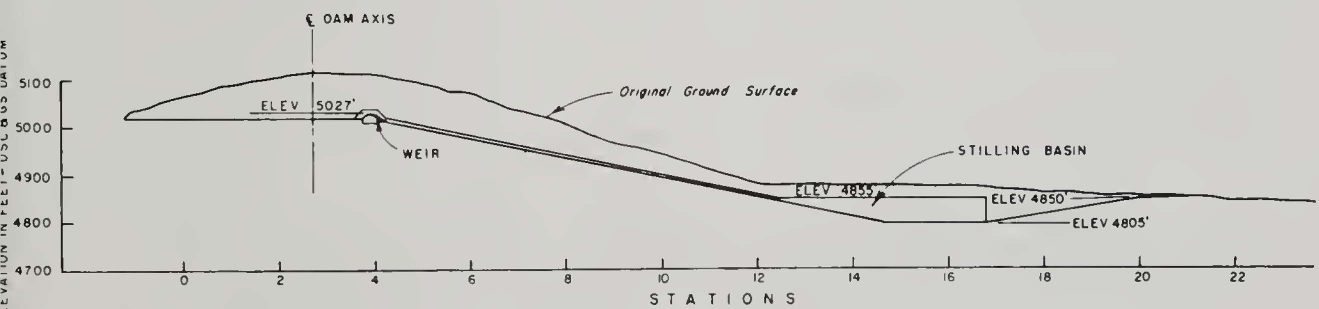
MAXIMUM DAM SECTION



PROFILE ALONG AXIS OF DAM

Stripping amounts to 340,000 cubic yards, of which 70 percent is salvageable for use in Zone 1. Total embankment required would be about 2,900,000 cubic yards.

Spillway. The spillway, located on the right abutment, would be a concrete-lined chute type with an ungated ogee concrete dam section 300 feet long and a capacity of 25,000 cfs. The approach apron would be lined to 30 feet ahead of the weir. The chute would taper to a 50-foot width at a point 500 feet downstream of the weir with a constant width of 50 feet below this point. Energy would be dissipated by a 220-foot-long and 50-foot-deep stilling basin just before the discharge is returned to the stream channel. The diagram below shows a profile of the spillway.



PROFILE OF SPILLWAY

SCALE OF FEET

0 200 400

Outlet Works. The outlet works for Jonesville Dam was designed to discharge 140 cubic feet per second at the minimum pool elevation of 4930 feet. A three-foot diameter, 1,200-foot-long cut-and-cover conduit would be placed along the right side of the stream channel. To control releases and dissipate the energy of discharge, a 24-inch Howell-Bunger valve would be installed at the outlet of the conduit.

Recreation Facilities. Jonesville Reservoir has a good recreation potential, in spite of the disadvantage of limited accessibility. Suitable facilities could be located near the reservoir at almost any point on the perimeter, thereby taking advantage of the gentle slopes, good tree cover, and aesthetic surroundings.

Facilities would include large camping areas adjacent to the northwest corner of the reservoir, picnic areas and a large sandy beach along the north shore, and a boat launching area adjacent to these facilities. The facilities would be sized to accommodate 130,000 visitor-days per year initially and about 310,000 visitor-days per year by the end of the period of analysis. Facilities costs were based on Department of Parks and Recreation standards.

Fishery Preservation and Enhancement. Specific features for fishery preservation would include the construction of a multiple-outlet structure and maintenance of a minimum pool of 15,000 acre-feet during all normal operating conditions. Provisions for fishery enhancement would include the adoption of a fish planting program by the project sponsor.

Wildlife Preservation. Jonesville Reservoir would inundate 470 acres of wildlife habitat of which 100 acres is prime meadow and marshland suitable for deer range. Department of Fish and Game studies recommend purchase of meadowlands on Willow Creek and lands adjacent to the reservoir to compensate for this loss. The land could be developed by the State and then turned over to the Forest Service for management.

Primary Distribution System. The Cohasset, Forest Ranch, and Eden Service areas, along with the Paradise Irrigation District, would be served by the Jonesville Project. Four small diversion dams and approximately 60 miles of conduit would supply domestic water to these ridge areas. (See Figure 8).

Butte Meadows diversion dam, located on Butte Creek three miles south of the main dam, would divert water into the 2-mile Butte-Big Chico conduit for transport to Big Chico Creek. Another small diversion dam on Big Chico Creek near Soda Springs would redivert this water to Cohasset Ridge via the 22-mile Cohasset Ridge conduit. Two more small diversion dams on Butte Creek would deliver water to the remaining areas. The Carpenter diversion dam, located about six miles downstream of Butte Meadows, would serve the Forest Ranch ridge area via 24 miles of gravity flow conduit. The Inskip diversion dam, located ten miles downstream from Butte Meadows, would supply additional water to the Eden Ridge area and to the Paradise Irrigation District via the 12-mile Magalia-Paradise Ridge conduit.

Summary of Project Costs. A summary of the estimated project costs during the 100-year period of analysis is presented in Table 16. The initial capital outlay for this project is estimated to be $11,490,000. The present worth of the total expenditures during the 100-year period of analysis is estimated to be $16,290,000. The average annual equivalent cost would be $665,000.

TABLE 16

SUMMARY OF JONESVILLE PROJECT COSTS

Project Feature	Present Worth: Capital Cost	Present Worth: Operations Maintenance, Replacement and General Expense	Present Worth: Total	Average Annual Equivalent Cost
Jonesville Dam and Reservoir and Appurtenances	$ 8,190,000	$ 290,000	$ 8,480,000	$346,000
Recreation Facilities	2,010,000	4,040,000*	6,050,000	247,000
Primary Distribution Facilities	1,290,000	470,000	1,760,000	72,000
Total	$11,490,000	$4,800,000	$16,290,000	$665,000

*Includes present worth value of future additions.

Project Accomplishments and Benefits

The Jonesville Project would provide a domestic water supply to the Cohasset, Forest Ranch, and Magalia-Paradise Ridges. Jonesville Reservoir would provide excellent water-associated recreation opportunities and a good reservoir trout fishery. The accomplishments and benefits from each of these project purposes are discussed in this section.

Conservation Yield. The Jonesville Project would yield 25,000 acre-feet per year, while maintaining the necessary downstream releases to provide for existing water rights and to protect the existing trout and salmon fisheries. The capitalized value of this yield (at $25 per acre-foot) would be $8,700,000, assuming a 1980 construction date and a 45-year demand buildup period.

There are several uncertainties involved in making the assumptions leading to evaluating this conservation yield benefit. The major items involve other possible future sources of water. There is some ground water potential in all these areas, but available information indicates that this source is quite limited and costly. It is possible that the Paradise Irrigation District may be able to purchase an existing water right on the West Branch of the Feather River. The P. I. D. is presently considering the construction of a new and enlarged Magalia Reservoir. Demand buildup projections prepared for this investigation indicate that even with the construction of this reservoir, the Jonesville Project will be needed at some time during the 1970's. Figure 10 is a graphic representation of the demand buildup and project staging for the Jonesville Project service areas.

Recreation. Jonesville Reservoir would provide an extremely attractive recreation area. The area is similar to that at Deer Creek Meadows, with beautiful meadows surrounded by stands of conifers. Camping, boating, picnicking, fishing, and swimming would be provided at the reservoir. With adequate facilities for the predicted demand, it is estimated that there will be 90,000 visitor-days of use annually at the beginning of project operation, and about 310,000 visitor-days of use annually by the end of the period of analysis.

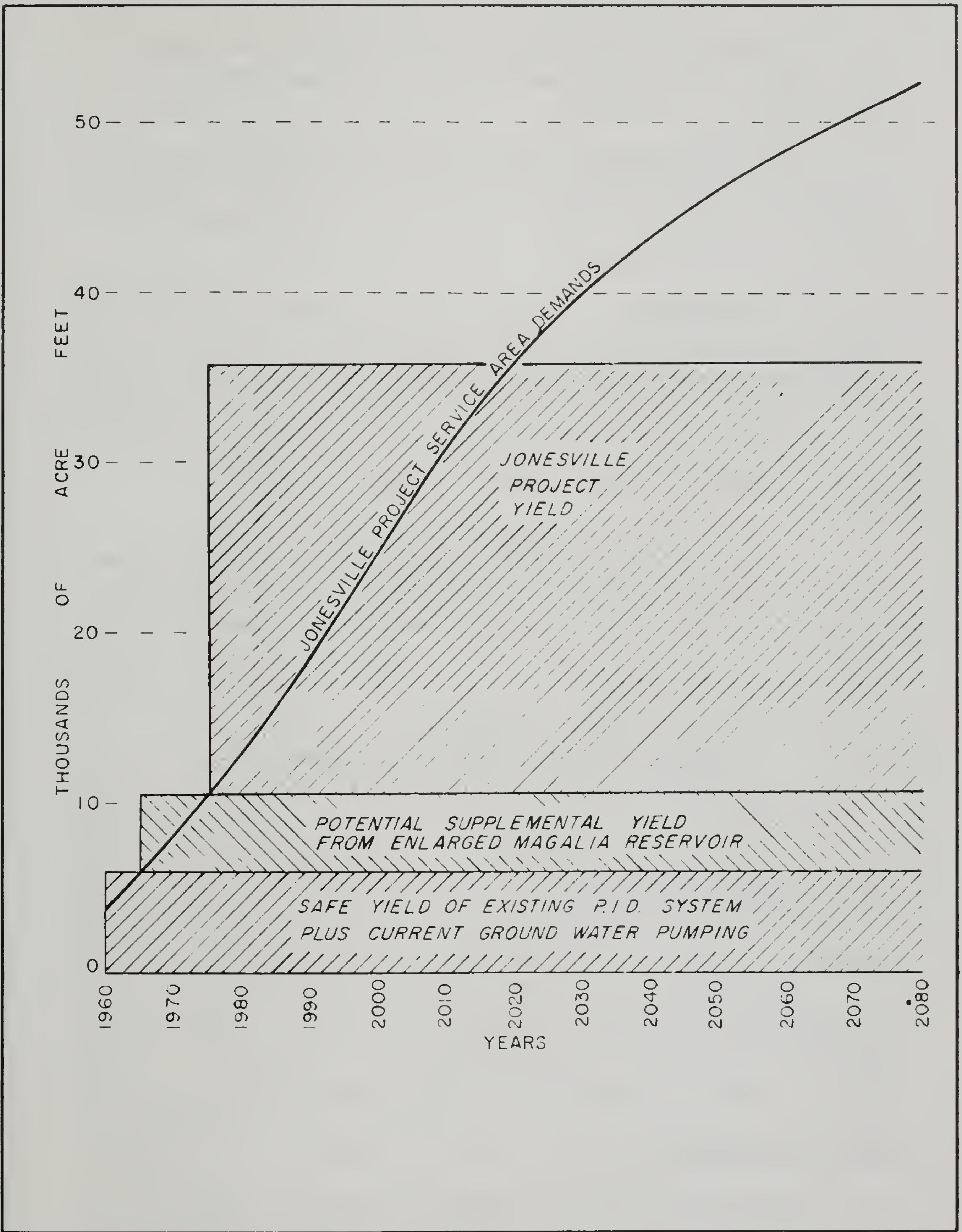


Figure 10. Jonesville Project Demand Buildup

Seventy-five percent of the use projected for this reservoir would be non-fishing oriented and would have a capitalized value of $6,800,000.

Fishery Enhancement. Fishery enhancement would be attained by this project from the creation of a good trout fishery in Jonesville Reservoir. The capitalized value of the recreation use supported by this fishery would be $2,900,000.

Flood Control. The only flood control benefit attained by the Jonesville Project would result from minor reductions in flood frequencies along the Sacramento River and in the Butte Basin. As explained earlier in this chapter, this benefit would have an annual unit value of 50¢ per acre-foot of live storage. The capitalized value of this benefit for the 39,000 acre-feet of live storage in Jonesville Reservoir would be $500,000.

Summary of Project Benefits. A summary of the estimated benefits for the Jonesville Project is presented in Table 17. The present worth value of the total benefits is $18,900,000; the average annual equivalent value is $771,000.

TABLE 17

SUMMARY OF JONESVILLE PROJECT BENEFITS

Project Purposes	Capitalized Benefits	Average Annual Equivalent Benefits
Conservation Yield	$ 8,700,000	$355,000
Recreation	6,800,000	278,000
Fishery Enhancement	2,900,000	118,000
Flood Control	500,000	20,000
Total	$18,900,000	$771,000

Economic Justification

The present worth value of project benefits throughout the period of economic analysis (1980-2080) was estimated at $18,900,000. The total capitalized cost of the project, including the present worth of all future expenditures, was estimated at $16,290,000. The resultant benefit-cost ratio is 1.16:1. Thus, if constructed in 1980 the Jonesville Project would be economically justified. It should be noted here that, using the same assumptions, the Jonesville Project would not show economic justification for construction in 1970. This project attains economic justification in about 1975.

Cost Allocation

A preliminary allocation of project costs was made to determine the amount of the total project costs that would be charged to each of the project purposes. A summary of the results of the allocation is presented in Table 18.

TABLE 18

PRELIMINARY COST ALLOCATION FOR
THE JONESVILLE PROJECT
(In average annual equivalent dollars)

	Recreation	Fishery Enhancement	Local Water Supply	Flood Control	Total
Benefits	278,000	118,000	355,000	20,000	771,000
Alternative Costs	346,000	247,000	418,000	1/	
Total Justifiable Costs	278,000	118,000	355,000	20,000	771,000
Separable Costs	173,000	74,000	255,000	0	502,000
Remaining Justifiable Expense	105,000	44,000	100,000	20,000	296,000
Percent Distribution	39.1%	16.3%	37.2%	7.4%	100.0%
Remaining Joint Costs2/	64,000	26,000	61,000	12,000	163,000
Total Allocated Costs	237,000	100,000	316,000	12,000	665,000

1/ Assumed to be in excess of benefits.
2/ Remaining joint costs are allocated in accordance with the percentage distribution of remaining justifiable expenses.

This sharing of costs would result in a unit water cost of about $22 per acre-foot. The addition of secondary distribution and treatment would result in a reasonable and competitive household charge for domestic water.

Possible Alternatives and/or Future Additions

Forks of Butte Reservoir (see Figure 2) was studied as an alternative to the Jonesville Project. Use of this reservoir as the major storage site for meeting the ridge area demands would necessitate the use of large pumping lifts. Studies for this investigation indicated that the Jonesville Project was the best alternative.

Forks of Butte could also serve as a possible distant future addition to the Jonesville Project. High-lift river run pumping, with no storage, might also serve as a future addition to the Jonesville Project.

It should be noted that the analyses presented for Jonesville assumed that the Paradise Irrigation District will construct a new Magalia Reservoir, at a capacity of 12,000 acre-feet, before the Jonesville Project would be initiated. It is also possible that the Paradise Irrigation District may be able to purchase a water right on the West Branch of the Feather River. There is some question as to the exact amount of water available through this means. However, it appears that the purchase of this water right could defer the need for the Jonesville Project by about 10 years (till 1985).

Belle Mill Project

The Belle Mill Project, located in Tehama County, consists of a dam and reservoir on Salt, Little Salt, and Millrace Creeks; a flood diversion system from Antelope Creek; downstream channel improvements on Salt and Millrace Creeks; and water-associated recreation facilities. As analyzed in this report, this project would be operated for recreation and flood control.

Hydrology

The natural drainage area tributary to Belle Mill Reservoir is about 38 square miles, and the drainage area tributary to the Antelope Creek diversion is about 124 square miles. Monthly flows at Belle Mill damsite were computed for the forty-year period from October 1, 1921, through September 30, 1961. Records were available for the Antelope Creek diversion from 1939 to date; flows prior to this were computed. The mean annual runoff for this 40-year period was 16,000 acre-feet at Belle Mill damsite and 91,000 acre-feet at the Antelope Creek diversion.

Flood frequency curves and a standard project flood hydrograph were prepared for the area tributary to Belle Mill damsite and Antelope Creek at the proposed diversion. In addition, a probable maximum flood of 17,000 cfs was computed for the area tributary to Belle Mill damsite.

Foundation Geology and Construction Materials

The report on a 1955 cursory examination of this site mentions foundation leakage as a possible major problem. However, present opinion (supported by exploration and testing at Crown damsite, 20 miles to the southeast in the same geologic formation, and by available well logs) is that the cemented gravels are sufficiently impervious to prevent leakage in dangerous amounts.

Fanglomerate from the reservoir area is proposed as the source of impervious fill. No testing of the fanglomerate was done, but similar material was tested and found suitable for impervious fill at the Crown Reservoir site, about 20 miles to the southeast.

Sand and gravel from the Sacramento River would be used as drain material, and basalt would be quarried from the Antelope Creek canyon for use as riprap.

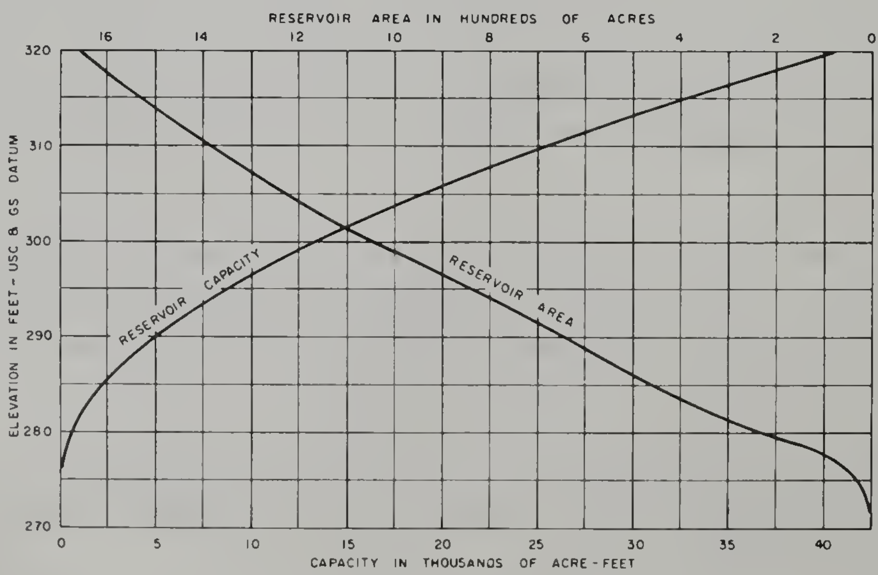
Project Features - Designs and Costs

This section describes the features of the Belle Mill Project and summarizes the project costs. The location of the project is shown on Figure 11. Table 19 presents the sizes and capacities of the project features.

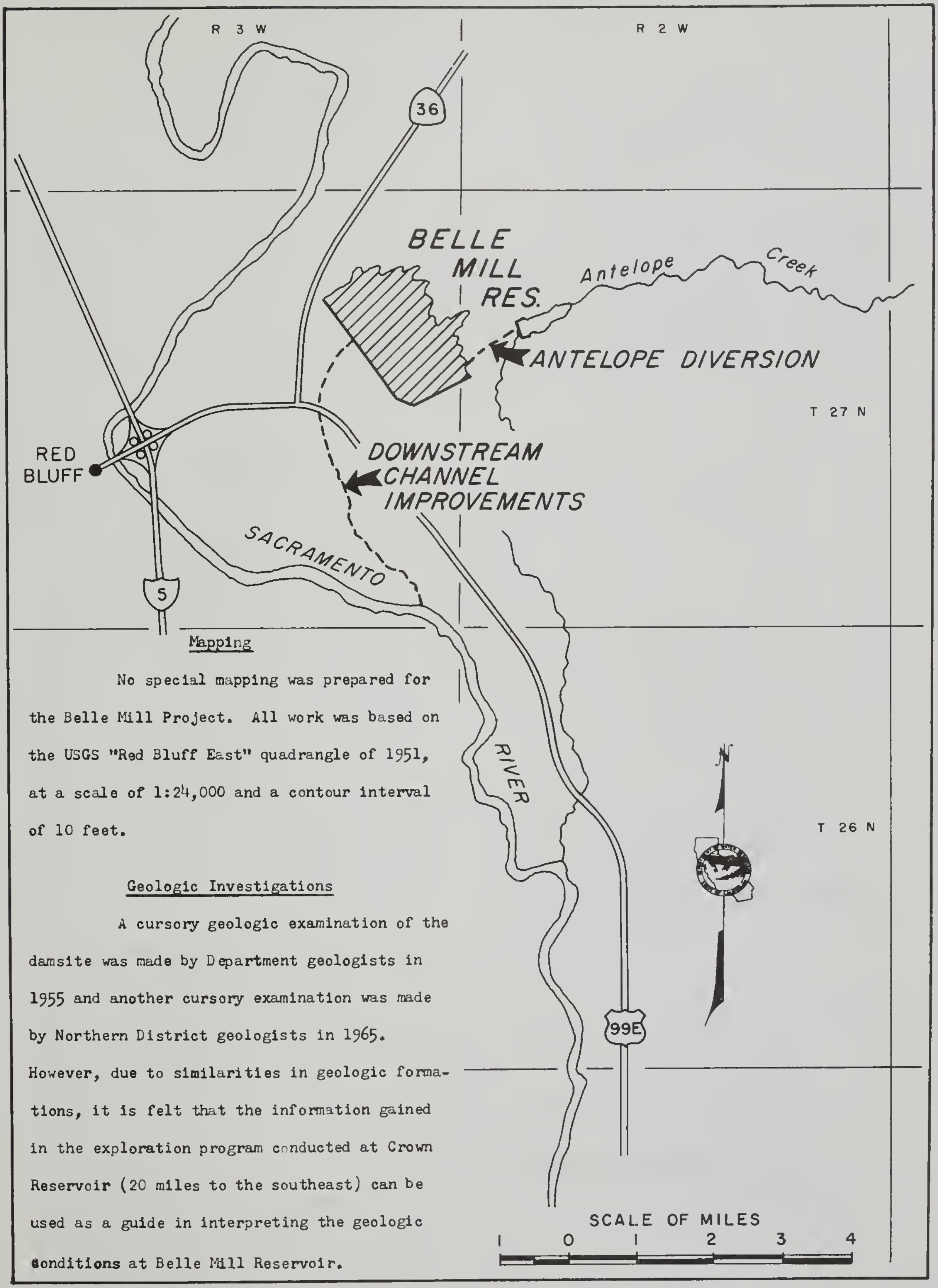
Antelope Diversion. The diversion dam would be a low concrete dam with a 200-foot ogee weir discharging into the diversion channel and a 30-foot ogee weir set 3 feet lower in elevation and discharging into Antelope Creek. The concrete dam would have a maximum height of 20 feet and a crest length of 400 feet. Two earthfill wing dams with a total length of about 600 feet would complete the diversion dam. A fish ladder would be incorporated into the dam near the Antelope Creek channel.

The 19,000-cfs capacity diversion channel would follow the natural channel of Millrace Creek and have a bottom width of 170 feet and a total length of 5,500 feet.

Belle Mill Reservoir. This reservoir would have a normal surface elevation of 302 feet, a gross storage capacity of 15,800 acre-feet and a water surface of 1,120 acres. Approximately 2,000 acres of land would have to be acquired to provide for surcharge storage and water-associated recreation use. There are only a few scattered trees and buildings in the reservoir area and about 4 miles of Belle Mill Road will have to be relocated around the southern edge of the reservoir. Figure 12 shows a layout of the Belle Mill Project and the diagram below shows area-capacity curves for Belle Mill Reservoir.



AREA - CAPACITY CURVES



Mapping

No special mapping was prepared for the Belle Mill Project. All work was based on the USGS "Red Bluff East" quadrangle of 1951, at a scale of 1:24,000 and a contour interval of 10 feet.

Geologic Investigations

A cursory geologic examination of the damsite was made by Department geologists in 1955 and another cursory examination was made by Northern District geologists in 1965. However, due to similarities in geologic formations, it is felt that the information gained in the exploration program conducted at Crown Reservoir (20 miles to the southeast) can be used as a guide in interpreting the geologic conditions at Belle Mill Reservoir.

Figure 11. Belle Mill Project Location Map

TABLE 19

BELLE MILL PROJECT FEATURES

PRIMARY PROJECT PURPOSES

Flood Control and Recreation

BELLE MILL RESERVOIR

Drainage area, in square miles......................................38
Maximum water surface elevation, in feet...........................309
Normal water surface elevation, in feet............................302
Minimum pool elevation, in feet....................................273
Capacity, at normal pool elevation, in acre-feet................15,800
Area of water surface at normal pool, in acres...................1,120

DAM

Location.Sec. 11, 13, 14, T27N, R3W and Sec. 18, T27N, R2W, MDB&M
Type.....................................Homogeneous earthfill
Height above streambed, in feet...............................40
Crest elevation, in feet.....................................312
Volume of fill, in cubic yards.........................2,700,000

SPILLWAY

Type..Ungated chute
Design capacity, in second-feet..........................33,000
Elevation of weir crest, in feet............................302
Length of weir crest, in feet...............................400

OUTLET WORKS

Conduit type....................................Cut and cover
Conduit size................................14 each - 6'x6'
Control type.....................................Slide gate
Control size....................................72" x 72"
Design capacity, in cubic feet per second 9,000

ANTELOPE CREEK DIVERSION

Type
Dam...................................Low concrete gravity
Conduit........................Improved existing stream channel
Location
Dam...............................Section 18, T27N, R2W, MDB&M
Conduit............From Antelope Creek into Belle Mill Reservoir
Size or capacity
Dam height, in feet..20
Conduit capacity, in cubic feet per second................19,000

DOWNSTREAM CHANNEL IMPROVEMENTS

Type.................................Improved natural stream channel
Location..Salt and Millrace Creeks
Capacity, in cubic feet per second..............................9,000

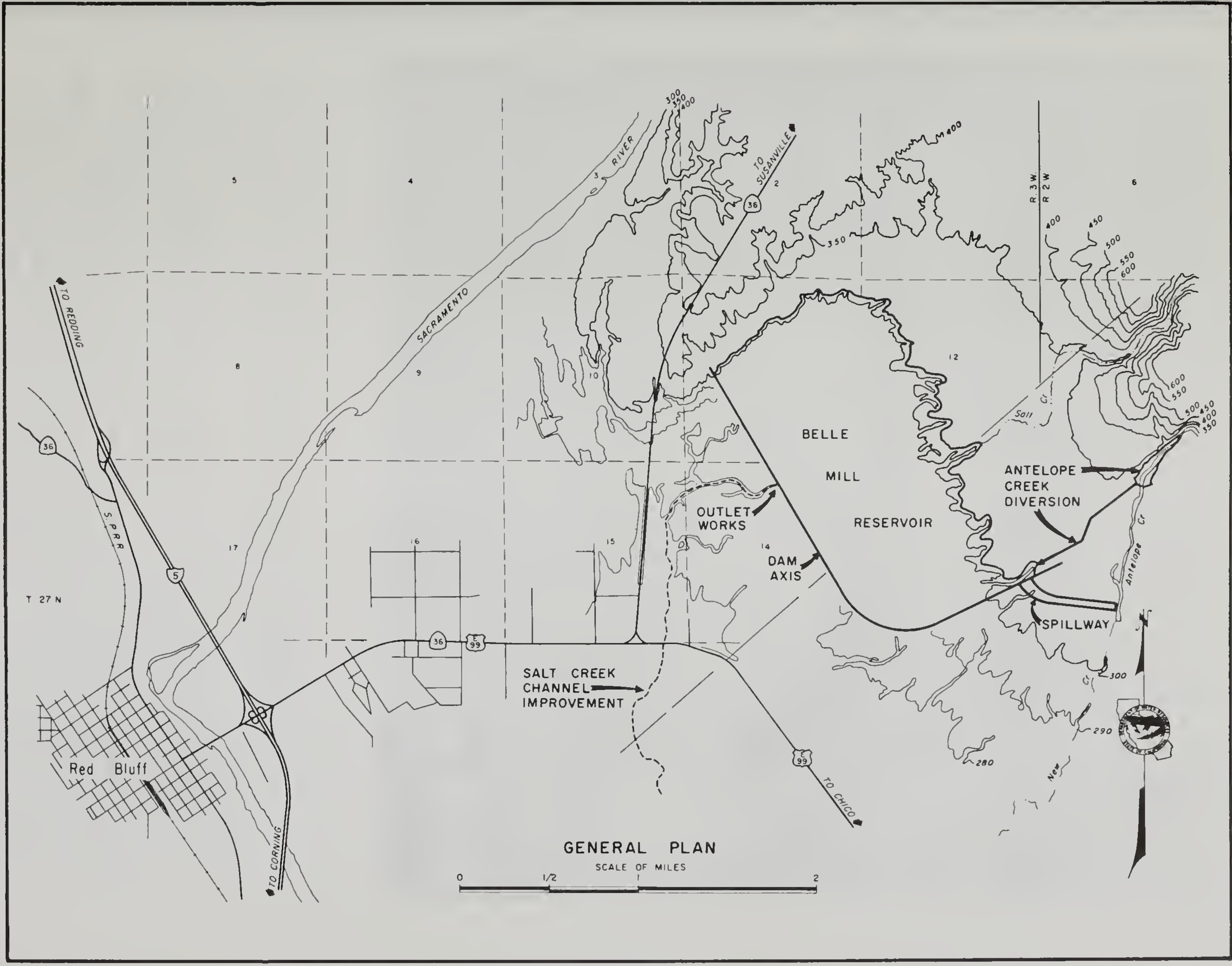
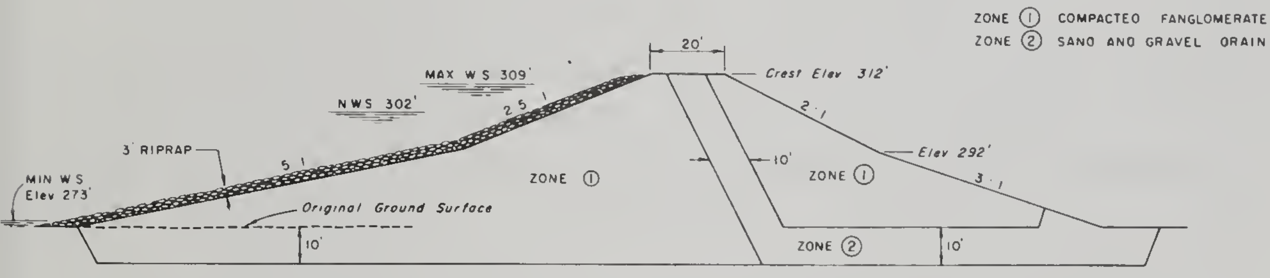


Figure 12. Belle Mill Project Layout

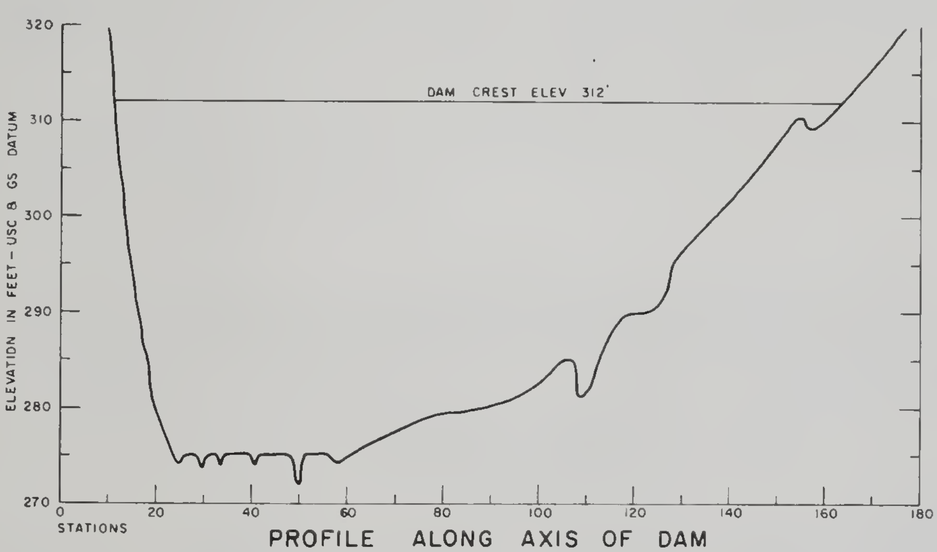
An artist's conception of Belle Mill Reservoir

Belle Mill Dam. Belle Mill Reservoir will be impounded by a 3-mile-long low earth dike. The dike would extend from the northwest $\frac{1}{4}$ of Section 11, T27N, R3W Mount Diablo Base and Meridian, a distance of 2 miles, to the southwest $\frac{1}{4}$ of Section 13, then northeast a distance of 1 mile to the southwest $\frac{1}{4}$ of Section 18, T27N, R2W. The dike would have a maximum height of 40 feet and an average height of about 20 feet. The dam would consist of a homogeneous compacted earthfill with internal gravel drains. The entire upstream slope would be riprapped. Side slopes would be 3:1 on the downstream slope up to elevation 292 feet and 2:1 above that elevation. The upstream slope would be 5:1 up to elevation 292 feet and 2.5:1 above that elevation. The dam crest would be at elevation 312 feet. The diagrams below show the maximum dam section and a profile along the dam axis.



MAXIMUM DAM SECTION

SCALE OF FEET
0 25 50

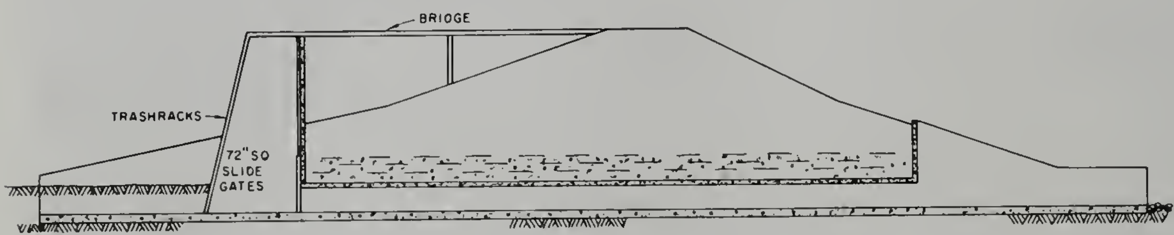


PROFILE ALONG AXIS OF DAM
LOOKING UPSTREAM
VERTICAL EXAGGERATION = 200:1

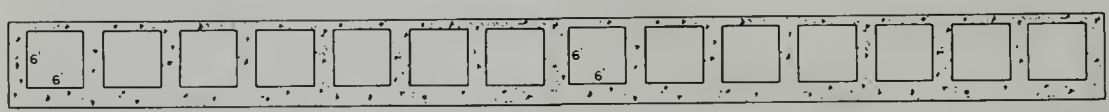
Foundation preparation would consist of removing an average of 10 feet of top soil to expose the fanglomerate member.

Spillway. An uncontrolled overflow, chute-type spillway would discharge into Antelope Creek via a ½-mile-long, partially lined channel. The 400-foot-long spillway crest (elevation 302 feet) would pass the peak design inflow of 36,000 cfs (17,000 from natural drainage and 19,000 by diversion) at a peak outflow of 33,000 cfs with a maximum head of 7 feet, leaving a nominal freeboard of 3 feet to the dam crest.

Outlet Works. The outlet works would be capable of making a 9,000-cfs flood control release into an improved Salt-Millrace Creek channel. The cut-and-cover outlet works would be made up of fourteen parallel 6 x 6-foot square conduits that would pass under the dam in the northeast $\frac{1}{4}$ of Section 14. A concrete intake structure extending to the dam crest elevation would house both the trashrack assembly and the fourteen slide gates. The diagrams below show a profile and cross-section of the outlet works.



OUTLET WORKS PROFILE



SECTION OF OUTLET CONDUIT

Millrace Channel Improvement. During times of heavy flooding the outlet works would discharge 9,000 cfs into Salt Creek below Belle Mill Reservoir. The natural capacity of this channel in the reach between the proposed dam axis and the point where it enters Millrace Creek averages about 3,000 cfs; from this point to the Sacramento River the natural capacity of Millrace Creek averages about 4,000 cfs. Thus it would be necessary to enlarge and straighten these natural channels to enable them to handle the outlet works design capacity.

Recreation Facilities. Almost all of the eastern perimeter of the reservoir would be suitable for recreation development. The area is almost all native pasture and would require landscaping. The recreation facilities would be sized to accommodate about 65,000 visitor-days per year initially and about 300,000 visitor-days ultimately. Facilities costs were based on Department Parks and Recreation standards.

Fishery Preservation and Enhancement. Specific features for fishery preservation at this project would include a fish ladder and adequate screening at the Antelope Creek Diversion Dam. Specific provisions for fishery enhancement would consist of the initial stocking of Belle Mill Reservoir with warmwater game fish.

Wildlife Preservation. Belle Mill Reservoir would inundate 1,120 acres of nearly barren land. The existing wildlife use of this area is insignificant and no mitigation program will be required.

Summary of Project Costs. A summary of the estimated project costs during the 100-year period of analysis is presented in Table 20. The initial capital outlay for this project is estimated to be $11,500,000. The present worth of the total expenditures during the period of analysis is estimated at $13,680,000. The average annual equivalent cost would be $559,000.

TABLE 20

SUMMARY OF BELLE MILL PROJECT COSTS

Project Feature	Present Worth: Capital Cost	Present Worth: Operation, Maintenance Replacement, and General Expense	Present Worth: Total	Average Annual Equivalent Cost
Belle Mill Dam & Reservoir & Appurtenances	$11,000,000	$ 190,000	$11,190,000	$457,000
Recreation Facilities	500,000	1,990,000*	2,490,000	102,000
Total	$11,500,000	$2,180,000	$13,680,000	$559,000

* Includes present worth value of future additions.

Project Accomplishments and Benefits

The Belle Mill Project would provide full flood protection on Antelope Creek against the standard project flood. When this flood, whose 23,000 cfs peak has a frequency of about once in 200 years, occurs on Antelope Creek, the Antelope Creek Diversion would divert 19,000 cfs into Belle Mill Reservoir while releasing 4,000 cfs down Antelope Creek. The flood storage reservation in Belle Mill Reservoir would be utilized to handle the peak inflow of 19,000 cfs from the Antelope Creek Diversion plus 3,000 cfs from Salt Creek, while maintaining a safe maximum release of 9,000 cfs into the improved Salt-Millrace flood channel.

As the flood season waned in the spring, the flood storage reservation in Belle Mill Reservoir would be gradually decreased, thus enabling the reservoir to fill during normal or wet years and provide an excellent stable recreation pool through the summer months. As the flood season approached in the fall, the reservoir would again be emptied to ensure adequate flood protection during the flood season.

Maintenance of a small minimum pool through the flood season would ensure the survival of warmwater game fish in the reservoir, thus providing fishing sport during the recreation season.

The accomplishments and benefits from each of these project purposes are discussed in this section.

Flood Control. The Belle Mill Project would provide full protection against the standard project flood (23,000-cfs peak) on Antelope Creek and Salt Creek. Figure 13 is a hydrograph of the standard project flood on Antelope Creek. Based on U. S. Army of Corps of Engineers flood damage surveys and population growth rate in the flood plain, this protection would result in an average annual flood control benefit of $112,000.

In addition to this local benefit there would be a remote benefit for reduction of flood peaks downstream along the Sacramento River and in the Butte Basin. This benefit was assumed to be $1.00 annually per acre-foot of storage for this reservoir (as opposed to the previously described 50¢ value). This increased value is justified because all of the storage at Belle Mill Reservoir is dedicated to flood

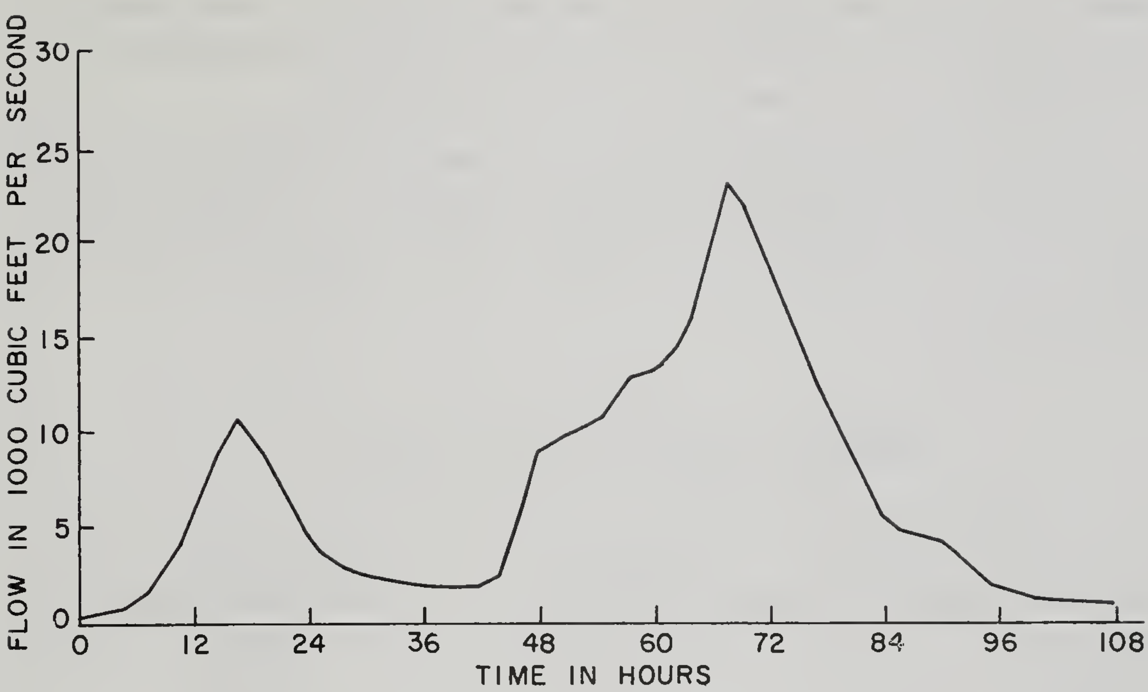


Figure 13. Standard Project Flood Hydrograph - Antelope Creek

control. Other reservoirs for which the 50¢ value was derived were operated primarily for water conservation and would not be nearly as effective in reducing flood peaks.

The combined local and remote benefits would have a capitalized value of about $3,100,000.

Recreation. The operational plan for this reservoir would result in a nearly full reservoir through the peak recreation season during normal and wet years. During dry years the reservoir would be essentially empty during the recreation season. With adequate facilities provided, it is estimated that there would be 35,000 visitor-days of use annually at the beginning of the project operation and 300,000 visitor-days of use annually by the end of the period of analysis.

Eighty-five percent of this use would be non-fishing and would have a capitalized value of $3,400,000.

Fishery Enhancement. The only fishery enhancement for this project would be the creation of a fair warmwater fishery in Belle Mill

Reservoir. It is estimated that 15 percent of the total recreation use would be supported by this fishery. This would create a fisheries enhancement benefit with a capitalized value of $600,000.

Summary of Project Benefits. A summary of the estimated benefits for the Belle Mill Project is presented in Table 21. The present worth value of the total benefits is $7,100,000; the average annual equivalent value is $290,000.

TABLE 21

SUMMARY OF BELLE MILL PROJECT BENEFITS

Project Purposes	Capitalized Benefits	Average Annual Equivalent Benefits
Flood Control	$3,100,000	$127,000
Recreation	3,400,000	139,000
Fishery Enhancement	600,000	24,000
Total	$7,100,000	$290,000

Economic Justification

The present worth of the benefits accruing to the project throughout the period of economic analysis (1970-2070) was estimated at $7,100,000. The total capitalized cost of the project, including the present worth of all future expenditures, was estimated at $13,680,000. The resultant benefit-cost ratio is 0.52:1. Thus, if constructed in 1970 the Belle Mill Project would not be economically justified. However, the population growth rate in the floodplain, the rapidly increasing property values in the floodplain, and the ever-increasing demands for water-associated recreation opportunities will probably enable this project to show economic justification in the future. Rough calculations indicate that this should occur around the year 2000.

Possible Alternatives and Future Additions

As stated in Chapter 1, there were several alternative storage projects analyzed in the Antelope Creek Basin (see Figure 2). There is one other alternative means of providing the much needed flood protection on Antelope Creek that was not evaluated during this investigation. That is the construction of channel improvements and levees only, with no reservoir storage. The U. S. Army Corps of Engineers is presently conducting studies to evaluate this type of project for Antelope Creek. They will also attempt to conduct a more detailed evaluation of the remote downstream benefits attributable to the Belle Mill Project.

There are two possible future additions (or other purposes) that should be evaluated again if the Belle Mill Project is restudied later. It is physically possible to build a much larger reservoir (Cone Grove) at this site. By so doing it might be possible to incorporate local water supply and fishery enhancement (in the form of an artificial spawning channel) into this project. These purposes were not feasible for inclusion at the time this investigation was concluded, but they may become so in the future.

CHAPTER 5. PROJECT IMPLEMENTATION

The usual steps in project implementation are reconnaissance studies, feasibility studies, authorization, final design, and construction. Chapters 1 through 4 of this report have presented the results of a reconnaissance study. This chapter discusses the work involved in conducting feasibility studies and attaining project authorization.

Feasibility Studies

For a project to be considered feasible for development it must generally possess the three following qualifications: (1) engineering feasibility, (2) economic justification, and (3) financial feasibility. In general terms a project is considered to possess engineering feasibility if it can be constructed safely by accepted techniques at a reasonable cost. While engineering feasibility has been determined to reconnaissance standards at the sites selected in this report, additional geologic exploration and detailed designs would be needed to bring this determination up to feasibility study standards.

Economic justification requires that the economic benefits exceed the economic costs of the project. Economic justification is generally expressed as a ratio of benefits to costs and is commonly called the benefit-cost ratio. Refined benefit and cost estimates should be completed to feasibility standards to demonstrate economic justification to the extent necessary for project authorization.

A project is considered to be financially feasible if funds for construction and operation of the project are available, and further, that reimbursable items can be repaid from the project revenues at the stipulated interest rate. One of the first steps in determining financial feasibility is the preparation of refined cost estimates. These estimates are needed to insure that funds authorized will be sufficient to complete project construction. Another vital step in determining financial feasibility is to allocate the total project cost among the various purposes served by the project. As discussed in Chapter 4, preliminary cost allocations were made in this reconnaissance-level study. However, preparation of refined cost allocations is one of the major purposes of feasibility studies and requires much more advanced data than are normally available in a reconnaissance-level study. A refined cost allocation identifies the reimbursable and the non-reimbursable project costs and thereby provides insight into the most logical methods of project financing and authorization.

Funds for the construction of the projects described in this report could come from a variety of sources. Among these are (1) state financial assistance for a project constructed by a local agency through grants and loans under provisions of the Davis-Grunsky Act, (2) state financing through specific special legislation, (3) federal financing as a unit of the Central Valley Project, (4) federal financing through grants and loans, (5) local financing through the sale of bonds, and (6) state financing as a facility of the State Water Resources Development System.

Recent activities regarding applications to appropriate unappropriated water from the Sacramento River or the Sacramento--San Joaquin Delta indicate that there is little or no available water supply during average or below-average water years. Therefore, several of the projects presented herein may be attractive to water users who desire to divert moderate quantities of water from the river or the Delta. This report shows that projects could be constructed in the east side area in a manner that would permit new firm water supplies to be extracted from the Sacramento--San Joaquin Delta at a low unit cost. However, if an agency other than the State were to consider construction for this purpose, the agency would have to reevaluate these projects to reflect its own needs and plans.

It is not within the scope of this report and it is not possible at this time to lay out a program showing all possible means of financing the projects. However, it is desirable that the most apparent known sources be pointed out to aid the agency that undertakes feasibility or advanced planning level studies of the projects.

Authorization

For those projects which augment water supplies in the Delta, it would be possible that they could be authorized as features of the California Water Resources Development System. This system consists of the State Water Facilities and such additional facilities as may be authorized by the Legislature as part of (1) the Central Valley Project or (2) the California Water Plan to meet local needs and to augment the supplies in the Sacramento--San Joaquin Delta. However, to date no financing is available in the current funding under the Burns-Porter Act for features other than those currently authorized as a part of the State Water Project. Since the Mill-Deer and Wing Projects help meet local needs and augment supplies in the Delta, authorization under the California Water Resources Development System may in the future be an appropriate means of advancing these projects.

As indicated previously, any agency desiring additional firm water supply in the Delta could authorize, finance, and construct projects tributary to the upper Sacramento River.

Another possibility would be through authorization by the Legislature of a grant and loan under the Davis-Grunsky Act. This act provides for state financial assistance to public agencies for the construction of water projects to meet local requirements by making grants or loans or both. Eligible projects include those primarily for domestic, municipal, agricultural, recreational, or fish and wildlife purposes, and in conformance with the California Water Plan. Grants are available for that portion of the construction cost properly allocated to recreation and fisheries enhancement. The portion of the project cost allocated to Delta water supply could be financed by the State under a clause in the act which provides for state participation in such projects when constructed larger than required for local needs. This course of action appears appropriate for the Jonesville Project because of its larger local water supply benefits. However, before a grant or loan could be made under the Davis-Grunsky Act, it would be necessary to initiate and complete a feasibility study.

The possibilities of federal financing of any of these projects as units of the Central Valley Project seem remote at this time. However, federal financing and U. S. Corps of Engineers construction of the Belle Mill Project, or a suitable alternative, is a very strong possibility. The possibility of local financing of the Mill-Deer and Wing Projects through the sale of bonds appears remote, since a small percentage of the benefits attained by these projects are local benefits. The Jonesville Project, on the other hand, has large local water supply benefits and should be studied by a county-wide district in Butte County.

One of the major obstacles to be overcome in implementing the development of a local water project is the lack of readily available funds to conduct feasibility studies. This is especially true where the local project would have large non-reimbursable costs. A local agency may be reluctant or unable to bear the high planning costs associated with projects of this nature. On the other hand, obtaining authorization of a primarily local water development project under the California Water Resources Development System may also be difficult.

For any project having large local benefits and for any method of project implementation pursued, local initiative and action will be needed to move a project towards construction. No legislative or congressional action is likely for any of the projects described in this report without strong and vociferous local support. The first step in project implementation for any local area is the dissemination of knowledge of promising local developments. This report has been prepared to help provide that knowledge.

Appendix A

BIBLIOGRAPHY

APPENDIX A. BIBLIOGRAPHY

Several reports of federal, state, and local agencies were reviewed in conducting the Sacramento Valley East Side Investigation. This bibliography tabulates these reports by agency and includes a brief description of those reports that are especially pertinent to this investigation.

California Department of Water Resources

Four previous investigations conducted by the Department are of major importance to this report.

Statewide Water Resources Investigation

In recognition of the growing statewide water problems, the Legislature, by Chapter 1541, Statutes of 1947, authorized the Statewide Water Resources Investigation. This investigation was conducted by the Division of Water Resources, under the direction of the State Water Resources Board. Funds were appropriated annually by the Legislature over a 10-year period for the completion of this important program of study. Results of the investigation were published in three bulletins. Bulletin No. 1, "Water Resources of California", published in 1951, contains a compilation of data on precipitation, unimpaired streamflow, flood flows and frequencies, and quality of water. Bulletin No. 2, "Water Utilization and Requirements of California", published in 1955, sets forth estimates of present and forecasts of probable ultimate water requirements throughout the State based in general on the capabilities of the land to support further development. The third and concluding phase of the Statewide Water Resources Investigation was reported in Bulletin No. 3, "The California Water Plan", published in 1957. The California Water Plan is a comprehensive master plan for the full development of the water resources of the State to meet present and future needs for all beneficial purposes in all parts of the State, insofar as practicable. The Legislature, by enactment of Chapter 2053, Statutes of 1949, adopted The California Water Plan as a general guide for the orderly and coordinated development and utilization of water resources of the State.

Northeastern Counties Investigation

The Northeastern Counties Investigation was initiated in 1954. This investigation evaluated the ultimate water needs of 15 counties in northeastern California, predicated upon full development of all natural resources. All of the Sacramento Valley east side area was included in this study. A report on the investigation, Bulletin No. 98, "Northeastern Counties Investigation", was published in 1960.

Coordinated Statewide Planning Studies

Pursuant to Chapter 61, Statutes of 1956, now contained in Section 232 of the California Water Code, the Department of Water Resources is conducting an investigation to determine in detail: the amount of water resources available in the separate watersheds in the State; the amounts of present and ultimate water required for beneficial uses in those watersheds; and, from the foregoing, the quantities of water, if any, available for export from the watersheds of origin. This continuing investigation resulted in the publication of Bulletin No. 160-66, "Implementation of the California Water Plan", in 1966.

Upper Sacramento River Basin Investigation

This six-year comprehensive study of the Sacramento River and its tributaries between Shasta Dam and Red Bluff developed plans for local water development projects similar in concept to those studied in the Sacramento Valley East Side Investigation. Bulletin No. 150, preliminary edition of the "Upper Sacramento River Basin Investigation", was published in 1965. At the request of the Legislature, this investigation was reopened in July 1966. During the extension of this investigation special emphasis will be placed on the development of a basin wide master plan for flood control.

Department of the Interior, Bureau of Reclamation

"Sacramento Canals Unit, Sacramento River Division, Central Valley Project, California". 1951.

An unpublished report on the Chico Canal Service Area.

United States Army, Corps of Engineers

"Master Manual of Reservoir Regulation, Sacramento River Basin, California".

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"Geologic Features and Ground Water Storage Capacity of the Sacramento Valley, California". 1961. Water supply paper 1947.

"Interchange of Surface and Ground Water Along Tributary Streams in the Central Valley, California". 1961.

"Water Power Resources of Mill and Deer Creeks, California". 1941.

United States Fish and Wildlife Service

"An Investigation of Fish-Salvage Problems in Relation to Shasta Dam". Special Scientific Report No. 10. 1940.

"Supplementary Report on Investigations of Fish-Salvage Problems in Relation to Shasta Dam". Special Scientific Report No. 26. 1943.

"Upper Sacramento River Sport Fishery". Special Scientific Report No. 34. 1950.

"Preliminary Report on Fish and Wildlife Resources, Butte Basin, California". 1954.

Local Agencies and Engineering Consulting Firms

"Preliminary Reconnaissance Watershed Survey, Antelope Creek, Salt Creek and Tributaries", prepared for the Lassen View Soil Conservation District by Charles S. McCandless and Company. 1963.

"Water Rate Study for Paradise Irrigation District", by William Stava, Consulting Engineer. 1964.

"Engineering Report, Transmission and Distribution System, Paradise Water Works", by Dean S. Kingman, Consulting Engineer. 1962.

Appendix B

RECREATION

By
Department of Parks and Recreation

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF PARKS AND RECREATION
DIVISION OF BEACHES AND PARKS

SACRAMENTO VALLEY EAST SIDE INVESTIGATION

RECREATION STUDY

By
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Recreation Planner III

Under the Supervision of:

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Assistant Supervisor

William J. Haussler
Supervisor

Recreation Contract Services Unit

March 1966

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TABLES

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SACRAMENTO VALLEY EAST SIDE INVESTIGATION

Introduction

This report has been prepared by the Recreation Contract Services Unit, Division of Beaches and Parks, in partial fulfillment of the services contracted by the Department of Water Resources under Interagency Agreement No. 254287. Specific authorization for recreational services for the Sacramento Valley East Side Investigation is contained in Department of Water Resources' work authority No. 254. This work authority requests that the Recreation Contract Services Unit complete recreation studies to determine the recreation use at proposed project reservoirs, and to develop plans to determine the types, locations, and staging of recreation facilities that would be constructed at proposed project reservoirs. Eleven proposed reservoirs were selected for the purposes of this recreation study. These eleven reservoirs are:

1. Deer Creek Meadows
2. Wing
3. Jonesville
4. Belle Mill
5. Crown
6. Facht
7. Forks of Butte
8. Hogback
9. Dehaven
10. Web Hollow
11. Savercool

Table No. 1 presents statistical information pertaining to the reservoirs listed above.

Table 1

Proposed Reservoir Data

SACRAMENTO VALLEY EAST SIDE INVESTIGATION

Name of Reservoir	Location (all MDB&M)	Height of Dam*	Features of Normal Pool			Features of Dead Pool		
			Storage A.F.	Elevation	Surface Area Ac.	Storage A.F.	Elevation	Surface Area Ac.
Deer Creek Meadows	S21,T28N,R5E	138	150,000	4,700	2,000	20,000	4,605	750
Wing	S25,T29N,R3W	175	230,000	500	3,600	5,000	365	250
Jonesville	S14,T26N,R4E	252	47,000	5,020	460	15,000	4,960	140
Belle Mill	T27N,R3W	40	15,800	302	1,120	2,000	284	400
Crown	T24N,R1W	50	11,000	304	680	1,000	283	130
Facht	S5, T27N,R1W	260	75,000	1,040	715	5,000	870	125
Forks of Butte	S27,T24N,R3E	265	57,000	2,350	520	3,000	2,150	80
Hogback	S9, T27N,R2W	230	30,500	660	385	2,500	520	65
Dehaven	S21,T27N,R2W	150	10,000	520	185	600	420	30
Web Hollow	S5, T24N,R3E	160	13,300	2,260	230	500	2,150	30
Savercool	S13,T27N,R2E	170	6,750	2,400	105	5,400	2,340	115

* Height does not include freeboard or stripping

For the purposes of this report, it was agreed that the information presented would be to designate the amounts of recreational use which could be expected at the project reservoirs along with associated recreation costs to accommodate this estimated use. More specifically, tables have been prepared for the reservoirs showing capital outlay expenditures required to accommodate this estimated recreation use for the 100-year repayment period. Also included are the operation, maintenance, and replacement costs. This information is listed by decades for a 100-year repayment period beginning in the decade 1970-1980. The tables showing estimated costs and visitation associated with the proposed east side reservoirs are accompanied by brief descriptive material and plates for the reservoirs studied in more detail. In addition, information is presented on estimated visitor origin and other data necessary for economic feasibility analysis.

Recreation Reconnaissance

Location of the Study Area

The Sacramento Valley East Side Investigation study area consists of a 2,000 square mile area in the northeastern portion of the Central Valley of California (Plate No. 1). The area includes the watersheds of Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks and several smaller tributary streams. Runoff from the area is almost completely uncontrolled, since there are no existing reservoirs having more than a few thousand acre-feet of storage capacity. Due to the potential for water conservation projects in this investigation area, the Department of Water Resources undertook a comprehensive investigation to formulate water development plans.

Accessibility

The major highway serving the study area is Highway 99E. Two other state highways of note traversing the study area are State Highways 36 and 32. In fact, these two highways intersect at the proposed reservoir site for Deer Creek Meadows.

Topography and Geology

The east side streams of the Upper Sacramento Valley are distinguished from other streams of the Sierra by their parallel courses and their steep descent from the headwaters or headwater valleys to the Sacramento Valley floor with few tributaries and little opportunity for water storage en route. The eastern portion of Tehama County, which comprises most of the study area, is covered with a succession of lava flows. These flows range from Pliocene basalt to Recent andesite and rhyolite flows from Mt. Lassen and other volcanic vents in the Cascade Mountains. Marine sediments of Carboniferous and Cretaceous Ages are exposed beneath the lavas in the canyons of the creeks flowing westward from the mountains. Nonmarine sediments ranging from Pliocene to Recent extend some 20 miles east and west from the Sacramento River.

Climate

Altitudinal variations are most significent in affecting temperatures and precipitation for the study area. The surface elevations of the proposed reservoirs vary from 302 feet for Belle Mill Reservoir to 5,020 feet for Jonesville. The precipitation in the area of investigation varies from about 25 inches per season in the western foothills to more than 70 inches at the eastern mountain boundary. Much of this latter precipitation falls as snow, which along with the porous character of the upper watersheds tends to equalize the runoff to some extent. Temperature variations occur from the 100 degree summer daytime temperature of the Sacramento Valley to the freezing temperature of the Deer Creek Meadows area during the winter.

Vegetative Cover

The vegetative cover types of the study area vary from the agricultural fields in the lowlands to the grasslands and chaparral belts on up into the coniferous stands of the higher reaches.

History

The first recorded historic expedition into Tehama County was that of the Spanish explorer Louie Arguello, who in 1821 entered the area of investigation. The first American was Jedediah Strong Smith, who entered the area in 1828. In 1843, John Bidwell and Peter Lassen chased horse thieves through the area to the vicinity of Red Bluff. It was on this trip that Lassen selected the land which was later granted to him by the Mexican government. The Lassen trail traverses the study area and was the route of the first northern emigrant group in California from the East. The earliest emigrant party to come over the trail started from Missouri in the spring of 1848 under the leadership of Peter Lasse The Lassen trail crosses the Deer Creek Meadows proposed reservoir site.

One fascinating historical aspect of the Sacramento Valley East Side Investigation area is the story of Ishi, who has been called "the last of the stone-age men" in North America. He was one of the surviving band of the Yahi Indians who moved into the Deer Creek drainage about 1890. This small band gradually diminished until Ishi was the only survivor. He came out and joined the civilized world in 1911 and was studied and written about extensively until his death on March 25, 1916.

Local Economy

The present economy of the northeastern counties located in the study area is based mainly upon the utilization of the natural resources of the area for agriculture, timber, and mining. In recent years recreation has become more and more prevalent and important in the development of the study area.

Existing Recreation Developments

The Lassen National Forest occupies a large portion of the upper reaches of the study area, and provides numerous campgrounds for the recreationists. The Tehama winter deer range managed by the California State Department of Fish and Game is in the study area.

The Department of Fish and Game also manages the Gray Lodge Waterfowl Management area in the southernmost portion of the study area near Gridley. The northern tip of the hydrographic area in this investigation extends into Lassen Volcanic National Park.

Reservoir Recreation Potential

The potential for the development of reservoir recreation areas is determined largely by evaluating the attractiveness and developability of the area. Other important factors are accessibility, location, the size of the reservoir, and the operation characteristics. In the recreation analysis, the latest operational data available from the Department of Water Resources was used. Often, further study results in operational changes. These changes must be analyzed from the recreation standpoint and when significant, the appropriate adjustments made to recreational design, use, and costs. The slopes surrounding the reservoir must be moderate enough to allow for development. Generally, they must not exceed 20 percent in gradient. Tree cover is very desirable for shade and esthetics and should be planted if it does not exist. The eleven proposed reservoirs that were included in this recreation evaluation were examined for these important characteristics and the following table resulted (Table No. 2). This table indicates the relative value for recreation of the proposed reservoirs. The first four were selected for more intensive evaluation.

Recreation Demand Potential

The study area itself has a relatively small population. Chico is the largest population center in the study area with a 1960

Table 2

SUMMARY OF RESERVOIR RECREATION POTENTIAL
SACRAMENTO VALLEY EAST SIDE INVESTIGATION

Reservoir Site	Attractiveness	Developability	Access	Size	Overall Potential
Deer Creek Meadows	G	G	G	G	G
Wing	F	G	G	G	G
Jonesville	G	G	P	F	G
Belle Mill	P	F	G	G	G
Crown	P	P	G	F	F
Facht	F	P	P	F	F
Forks of Butte	G	P	P	F	F
Hogback	P	P	F	P	P
Dehaven	P	P	F	P	P
Web Hollow	G	P	P	P	P
Savercool	G	P	P	P	P

G - Good
F - Fair
P - Poor

population of 14,800 and with 20,000 in the surrounding rural area. The study area is closely bordered by Red Bluff, Orland, Willows, Gridley, and other small Sacramento Valley towns. The populations of the three counties in northern Sacramento Valley at the 1960 census were: Butte, 82,000; Tehama, 25,000; and Glenn, 17,000.

The day use zones for the four reservoirs selected for more intensive study were set out in ten-mile concentric rings around the reservoir under study to 100 miles. Table 3 shows the results of the computations which utilized smoothed per capita rate curves taken from existing reservoirs and the population surrounding the study area to arrive at estimated origin of recreationists. These calculations also determined a figure that was used in predicting use at the proposed reservoirs after adjustment was made for attractiveness, access, developable land, reservoir size, and operation characteristics. For comparative purposes, Black Butte Reservoir's present recreation use was analyzed. This project received 77,000 visitor day's use in 1964, and since this was the first year of operation with good facilities, the Corps of Engineers expects a substantial increase in future use.

The overnight use was calculated by using 50-mile zones and the estimated percentages of use by distance zones are shown in Tables 4 and 5. The overnight use for Deer Creek and Jonesville utilized data gathered at the Lake Almanor campground, which is only 16 miles from the proposed Deer Creek Meadows Reservoir. For

Table 3

ESTIMATED ORIGIN OF DAY USERS
BELLE MILL, JONESVILLE, DEER CREEK MEADOWS, WING
RESERVOIRS BY DISTANCE ZONES

Distance Zones	Belle Mill	Jonesville	Deer Creek Meadows	Wing
0-10 miles	39.0%	.7%	2.1%	10.8%
11-20	20.4	5.8	9.6	51.2
21-30	21.6	45.5	11.2	23.9
31-40	12.9	33.6	34.6	3.3
41-50	2.1	5.7	27.5	6.6
51-60	1.2	1.8	4.6	.9
61-70	.5	2.0	1.5	.5
71-80	.4	.7	1.5	.2
81-90	.1	.1	.4	.2
91-100	.1	.1	.1	.1
100 +	1.7	4.0	6.9	2.3

Table 4

ESTIMATED ORIGIN OF CAMP USERS
DEER CREEK MEADOWS, JONESVILLE RESERVOIRS
BY DISTANCE ZONES

Distance Zone	Percentage
0-50 miles	0.0%
51-100	10.6
101-150	12.9
151-200	10.7
201-250	15.9
251-300	15.4
301-350	1.6
351-400	.3
401-450	1.7
451-500	1.2
501-550	22.7
551-600	2.2
601-650	3.1
651-700	1.7

Table 5

ESTIMATED ORIGIN OF CAMP USERS
WING AND BELLE MILL RESERVOIRS
BY DISTANCE ZONES

Distance Zone	Percentage
0-50 miles	11.0%
51-100	12.9
101-150	24.9
151-200	37.7
201-250	2.8
251-300	1.8
301-350	.5
351-400	.8
401-450	.3
451-500	6.4
500 +	.9

the two reservoirs in the western part of the study area, Wing and Belle Mill, a per capita curve was utilized which is the average of several northern conservation storage reservoirs. For comparative purposes, the Pacific Gas and Electric Company estimated a use of 200,000 visitor days at Lake Almanor in 1964.

It was assumed for the purposes of this study that the average number of people per party was four and that the length of stay for overnighters would be 2.85 days and for day users, 4.7 hours.

An allowance was made for the competition afforded by the Shasta, Whiskeytown, and Engle Lakes by discounting the population in this area that was in the predicted zone of use of the recreation study area.

The existing and projected existing use at a proposed reservoir site was subtracted from the predicted recreation use to arrive at a net use figure. The existing use is primarily hunting and fishing with some other miscellaneous recreational uses such as rock hunting.

Recreation Costs

Recreational development costs are based upon standard unit costs developed by the Recreation Contract Services Unit, Division of Beaches and Parks. (Table No. 6.)

The contingency amount of 5 percent was added along with 10 percent for escalation and 25 percent for the Office of Architecture and

TABLE 6

Recreation Unit Costs
Sacramento Valley East Side Investigation

Unit	Unit Costs	
Picnic	$ 2,700	
Camp	3,000	
Access Roads	3.60	per square yard
Boat Launching Ramps	4.50	per square yard
Launching Ramp Parking	2.00	per square yard
Beach	20,000	per acre
Landscaping	3,000	per acre

Construction. Recreation land costs were not included in this recreation study. The recreation operation and maintenance costs were computed at $.30 per visitor day. Annual replacement costs were calculated at the rate of 3.5 percent per annum at a cumulative rate over the life of the project. The recreation facilities were designed to accommodate a design load of 1 percent of the annual visitation for Wing and Belle Mill Reservoirs and 1.25 percent design load for Deer Creek Meadows and Jonesville Reservoirs. This design load difference is due to the higher peaking of annual visitation that occurs at higher elevation reservoirs, The capital costs for the seven reservoirs receiving less emphasis in this report were calculated by using a $5 per visitor day figure, which is an average figure of estimated costs. It must be recognized that this is a minimum figure because access costs would be rather high for most of these reservoirs. This cost figure is offered so a preliminary evaluation of these reservoirs can be made. If the preliminary reconnaissance stage is superseded by more detailed investigations, more detailed costs would have to be developed.

DEER CREEK MEADOWS RESERVOIR

The proposed Deer Creek Meadows Reservoir (Plate No. 2) would be located at the junction of State Highways 32 and 36, thirteen miles west of the town of Chester. The reservoir would be at an elevation of 4,700 feet and would have 2,000 surface acres at normal pool. This site had mapping available at 400 feet to the inch scale which made more accurate site planning possible. Quad sheets were utilized for the recreation evaluation at the other reservoir sites. The area is extremely attractive with excellent possibilities for recreational development. The two state highways would have to be relocated for the Deer Creek Meadows Reservoir project since the highways intersect in the proposed reservoir site. Because of the proximity of these highways, excellent access would be afforded to the proposed recreation facilities. A highway survey taken in Chester in 1961 indicated that 5,400 vehicles passed through town on an average day during the peak month. This certainly illustrates the number of people in this recreation area during the recreation season.

Plate No. 2 indicates the lands that are most suitable for recreational development. The initial recreation development is planned for the southern portion of the reservoir near the existing Highway 36. The physiography of this area is outstanding from a recreation standpoint. A reconnaissance of the Carter Creek area located glades in conjunction with open stands of mature conifers on lands that have moderate slopes. People utilizing recreation facilities developed in this area would overlook the reservoir with Mt. Lassen as a backdrop. Many classes of vegetative cover that can be expected at this altitude are found in the southern camping area, such as newly logged areas, dense brush areas, dense 20 to 40 foot high second growth coniferous forests and mature open stands. This variety of cover is conducive to the establishment of various recreation use areas with natural buffer zones.

The western peninsular area is not a suitable area for initial development but could be used for future recreational needs. The access from the shoreline to the developable land would be difficult for the recreationists because of the steep slopes and the area is the most isolated of the recreation areas. The peninsula is covered with second growth conifers and a dense understory of brush. The northern area, designated as a picnic area, consists of moderately timbered, gently sloping lands suitable for future development.

Table 7

DEER CREEK MEADOWS RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Camp Use	Day Use	Total Use	Use Without Project	Net Use
1 (1970-80)	271,000	68,000	339,000	9,000	330,000
2	425,000	106,000	531,000	14,000	517,000
3	600,000	153,000	753,000	20,000	733,000
4	600,000	210,000	810,000	28,000	782,000
5	600,000	278,000	878,000	37,000	841,000
6	600,000	352,000	952,000	47,000	905,000
7	600,000	436,000	1,036,000	58,000	978,000
8	600,000	530,000	1,130,000	71,000	1,059,000
9	600,000	635,000	1,235,000	85,000	1,150,000
10	600,000	700,000	1,300,000	100,000	1,200,000

Table 8

DEER CREEK MEADOWS RESERVOIR
ESTIMATED COSTS OF RECREATION FACILITIES BY DECADE

Decade		Picnic Site	Camp Sites	Boat Ramp sq. yds.	Boat Parking sq. yds.	Beach (acres)	Access Road sq. yds.	Water Supply	Sewer System	Subtotal	Overhead 40%	Total
1	Unit	50	800	5,400	13,400	1	28,000	1	1			
	Cost	135,000	2,400,000	24,300	26,800	20,000	100,800	300,000	150,000	3,156,900	1,262,760	4,419,660
2	Unit	25	500	2,700	6,700	1						
	Cost	67,500	1,500,000	12,150	13,400	20,000				1,613,050	645,220	2,258,270
3	Unit	25	550	2,700	6,700	1	28,000					
	Cost	67,500	1,650,000	12,150	13,400	20,000	100,800			1,863,850	745,540	2,609,390
4	Unit	25		2,700	6,700	1						
	Cost	67,500		12,150	13,400	20,000				113,050	45,220	158,270
5	Unit	25										
	Cost	67,500								67,500	27,000	94,500
6	Unit	25				1	28,000					
	Cost	67,500				20,000	100,800			188,300	75,320	263,620
7	Unit	50										
	Cost	135,000								135,000	54,000	189,000
8	Unit	50				1						
	Cost	135,000				20,000				155,000	62,000	217,000
9	Unit	50										
	Cost	135,000								135,000	54,000	189,000
10	Unit	50				1						
	Cost	135,000				20,000				155,000	62,000	217,000

Table 9

DEER CREEK MEADOWS RESERVOIR

ESTIMATED OPERATION,
MAINTENANCE AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Operation & Maintenance @ 30¢/V. D.	Replacement @ 3½% Capital inv.	Total OM&R
1 (1970-80)	339,000	$1,017,000	$1,105,000	$2,122,000
2	531,000	1,593,000	1,670,000	3,263,000
3	753,000	2,259,000	2,322,000	4,581,000
4	810,000	2,430,000	2,362,000	4,792,000
5	878,000	2,639,000	2,386,000	5,020,000
6	952,000	2,856,000	2,427,000	5,283,000
7	1,036,000	3,108,000	2,474,000	5,582,000
8	1,130,000	3,390,000	2,528,000	5,918,000
9	1,235,000	3,705,000	2,575,000	6,280,000
10	1,300,000	3,900,000	2,629,000	6,529,000

WING RESERVOIR

The proposed Wing Reservoir (Plate No. 3) would have a normal pool elevation of 500 feet with a surface acreage of 3,600 acres. The reservoir would lie in the Inks Creek drainage and would function as an off-stream storage reservoir of Paynes Creek. The access would be off Manton Road, which branches off State Highway 36 eleven miles from Red Bluff. The site of the proposed reservoir is at an elevation slightly above the Sacramento River in rolling hills.

There is sufficient developable land for suitable recreation developments on the southern shore of the proposed reservoir. This area is sparsely populated with oak trees and would require landscaping. There would be possibilities for recreation development below the dam at this site in the stretch of water that would exist from the dam to the Sacramento River. If more detailed studies are made of this reservoir, this area should be evaluated.

The present operational plan for the reservoir envisions a long-range cyclical conservation storage of water. The result of this operational plan would be that the reservoir would be approximately at its normal pool 80 percent of the time over a long-range period. Historical hydrological records indicate that the reservoir would have emptied over a six- or seven-year period, then would have refilled to normal pool and fluctuated with percolation and evaporation for the greater part of a 40-year period. This type of operational schedule would be favorable to recreation use.

Table 10

WING RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Camp Use	Day Use	Total Use
1 (1970-80)	26,000	60,000	86,000
2	41,000	95,000	136,000
3	59,000	137,000	196,000
4	81,000	189,000	270,000
5	106,000	248,000	354,000
6	136,000	317,000	452,000
7	168,000	392,000	560,000
8	204,000	476,000	680,000
9	244,000	570,000	814,000
10	288,000	671,000	959,000

Table 11

WING RESERVOIR

ESTIMATED COSTS OF RECREATION FACILITIES BY DECADE

Decade		Picnic Sites	Camp Sites	Boat Ramp (sq. yds.)	Boat Parking (sq. yds.)	Landscape (acres)	Beach (acres)	Access Road (sq. yds.)	Subtotal	Overhead 40%	Total
1	Unit	50	50	300	6,700	17.5	1	42,000			
	Cost	135,000	150,000	1,350	13,400	52,500	20,000	151,200	523,450	209,380	732,830
2	Unit	25	50	300	6,700	15					
	Cost	67,500	150,000	1,350	13,400	45,000			277,250	110,900	388,150
3	Unit	25	50			15					
	Cost	67,500	150,000			45,000			262,500	105,000	367,500
4	Unit	25	50	300	6,700	15					
	Cost	67,500	150,000	1,350	13,400	45,000			277,250	110,900	388,150
5	Unit	25	50			15					
	Cost	67,500	150,000			45,000			262,500	105,000	367,500
6	Unit	25	50	300	6,700	15					
	Cost	67,500	150,000	1,350	13,400	45,000			494,750	197,900	692,650
7	Unit	50	100	300	6,700	30					
	Cost	135,000	300,000	1,350	13,400	90,000			472,250	189,000	661,250
8	Unit	50	100	300	6,700	30	1				
	Cost	135,000	300,000	1,350	13,400	90,000	20,000		559,750	223,900	783,650
9	Unit	50	100	300	6,700	30					
	Cost	135,000	300,000	1,350	13,400	90,000			539,750	215,900	755,650
10	Unit	50	100	300	6,700	30					
	Cost	135,000	300,000	1,350	13,400	90,000			539,750	215,900	755,650

Table 12

WING RESERVOIR

ESTIMATED OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Operation & Maintenance @ 30¢/V.D.	Replacement @ 3½% Capital inv.	Total OM&R
1 (1970-80)	86,000	$ 258,000	$ 183,000	$ 441,000
2	136,000	408,000	280,000	688,000
3	196,000	588,000	372,000	960,000
4	270,000	810,000	469,000	1,279,000
5	354,000	1,062,000	561,000	1,623,000
6	452,000	1,356,000	734,000	2,090,000
7	560,000	1,680,000	847,000	2,527,000
8	680,000	2,040,000	1,043,000	3,083,000
9	814,000	2,442,000	1,232,000	3,674,000
10	959,000	2,177,000	1,421,000	4,298,000

JONESVILLE RESERVOIR

The proposed Jonesville Reservoir (Plate No. 4) would be located at an elevation of 5,020 feet with a normal pool surface acreage of 460 acres. The reservoir site lies at the junction of Colby, Willow, Jones, and Butte Creeks. This reservoir would be located about nine miles west of Butte Meadows on the Humbug Road. This places the reservoir about 15 miles from Highway 32. The present road to the summer homes of the Jonesville area travels through the proposed damsite. This area is very attractive; similar to Deer Creek Meadows in aspect with beautiful meadows surrounded by stands of conifers. Most of the land surrounding the proposed reservoir on the northeast side is suitable for recreation development. The State Fish and Game Department has shown interest in providing some mitigation features in and near the proposed recreation areas, and since there is sufficient land available there, the mitigation features for wildlife probably could be integrated satisfactorily with the recreation areas with little difficulty.

Table 13

JONESVILLE RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Camp Use	Day Use	Total Use	Use Without Project	Net Use
1 (1970-80)	62,000	7,000	69,000	1,000	68,000
2	98,000	11,000	109,000	2,000	107,000
3	142,000	16,000	158,000	3,000	155,000
4	195,000	22,000	217,000	4,000	213,000
5	224,000	28,000	252,000	6,000	246,000
6	224,000	36,000	260,000	7,000	253,000
7	224,000	45,000	269,000	9,000	260,000
8	224,000	54,000	278,000	11,000	267,000
9	224,000	65,000	289,000	13,000	276,000
10	224,000	77,000	301,000	15,000	286,000

Table 14

JONESVILLE RESERVOIR
ESTIMATED COSTS OF RECREATION FACILITIES BY DECADE

Decade	Picnic Site	Camp Site	Boat Ramp sq. yds.	Boat Parking sq. yds.	Beach (acres)	Access Road sq. yds.	Water Supply	Sewer System	Subtotal	Overhead 40%	Total
1 Unit	25	200	1,600	6,700	1	14,000	1	1			
Cost	67,500	600,000	7,200	13,400	20,000	50,400	100,000	50,000	909,500	363,800	1,273,300
2 Unit		100									
Cost		300,000							300,000	120,000	420,000
3 Unit		150									
Cost		450,000							450,000	180,000	630,000
4 Unit		150			1						
Cost		450,000			20,000				470,000	188,000	658,000
5 Unit		100									
Cost		300,000							300,000	120,000	420,000
6 Unit	25										
Cost	67,500								67,500	27,000	94,500
7 Unit											
Cost	CAPACITY REACHED										
8 Unit											
Cost											
9 Unit											
Cost											
10 Unit											
Cost											

Table 15

JONESVILLE RESERVOIR

ESTIMATED OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Operation & Maintenance @ 30¢/V. D.	Replacement @ 3½% Capital inv.	Total OM&R
1 (1970-80)	69,000	$ 207,000	$ 318,000	$ 525,000
2	109,000	327,000	423,000	750,000
3	158,000	474,000	581,000	1,055,000
4	217,000	651,000	746,000	1,397,000
5	252,000	756,000	851,000	1,607,000
6	260,000	780,000	875,000	1,655,000
7	269,000	807,000	875,000	1,682,000
8	278,000	834,000	875,000	1,709,000
9	289,000	867,000	875,000	1,742,000
10	301,000	903,000	875,000	1,778,000

BELLE MILL RESERVOIR

The Belle Mill Reservoir (Plate No. 5) would be located at an elevation of 302 feet approximately five miles east of the town of Red Bluff and would have a normal pool surface acreage of 1,120 acres. The reservoir would be where the drainages of Salt and Antelope Creeks emerge from the foothills. The reservoir site itself is barren of trees and very flat. There is some oak-grassland vegetation near the perimeter of the reservoir, but most of the reservoir site itself is pasture. Almost all of the eastern perimeter of the reservoir would be developable for recreation while the western perimeter would consist of the retaining levee. The access road to the reservoir would intersect State Highway 36 about four miles from Highway 99E, a major thoroughfare. The operational schedule presently planned for this reservoir would be beneficial to recreation. The reservoir would function as a flood control reservoir and would fill above the flood pool during the months of March, April and May, reaching the maximum pool for the year the first of June. During the latter part of September, the pool would be lowered for the next flood season.

Table 16

BELLE MILL RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Camp Use	Day Use	Total Use
1 (1970-80)	16,000	36,000	52,000
2	24,000	57,000	81,000
3	35,000	83,000	118,000
4	49,000	113,000	162,000
5	64,000	149,000	213,000
6	81,000	190,000	271,000
7	90,000	210,000	300,000
8	90,000	210,000	300,000
9	90,000	210,000	300,000
10	90,000	210,000	300,000

BELLE MILL RESERVOIR

ESTIMATED COST OF RECREATION
FACILITIES BY DECADE

Decade		Picnic Sites	Camp Sites	Boat ramp (sq.yds.)	Boat Parking (sq.yds.)	Landscape (acres)	Beach (acres)	Access Road (sq.yds.)	Subtotal	Overhead 40%	Total
1	Unit	25	50	1,200	6,700	15	1	22,000			
	Cost	67,500	150,000	5,400	13,400	45,000	20,000	79,200	380,500	152,200	532,700
2	Unit		50			12.5					
	Cost		150,000			37,500			187,500	75,000	262,500
3	Unit	25		1,200	6,700	2.5					
	Cost	67,500		5,400	13,400	7,500			93,800	37,500	131,300
4	Unit		50			12.5	1				
	Cost		150,000			37,500	200,000		207,500	83,000	290,500
5	Unit	25	50			15					
	Cost	67,500	150,000			45,000			262,500	105,000	367,500
6	Unit	25	50			15					
	Cost	67,500	150,000			45,000			262,500	105,000	367,500
7	Unit										
	Cost	CAPACITY REACHED									
8	Unit										
	Cost										
9	Unit										
	Cost										
10	Unit										
	Cost										

Table 18

BELLE MILL RESERVOIR

ESTIMATED OPERATION, MAINTENANCE AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Operation & Maintenance at 30¢/V. D.	Replacement at 3½% Capital Inv.	Total OM&R
1 (1970-80)	52,000	$160,000	$133,000	$293,000
2	81,000	240,000	199,000	439,000
3	118,000	350,000	232,000	582,000
4	162,000	490,000	305,000	795,000
5	213,000	640,000	397,000	1,037,000
6	271,000	810,000	489,000	1,299,000
7	300,000	900,000	489,000	1,389,000
8	300,000	900,000	489,000	1,389,000
9	300,000	900,000	489,000	1,389,000
10	300,000	900,000	489,000	1,389,000

OTHER PROPOSED RESERVOIRS

SACRAMENTO VALLEY EAST SIDE INVESTIGATION

The reservoirs of Crown, Facht, Forks of Butte, Hogback, Dehaven, Web Hollow, and Savercool are of lesser recreational import than the reservoirs so far discussed and will be treated as a group. Crown Reservoir would lie in the Sacramento Valley near the foothills with good access from Highway 99E, but would have a poor operational schedule with a drawdown commencing May 1 and continuing through the recreation season. Hogback and Dehaven reservoir sites lie in the Antelope and Salt Creek drainages near the eastern perimeter of the Belle Mill Reservoir. They are steep-sided reservoirs that would lie in the drainages cut through the extensive lava beds. Facht Reservoir would be farther upstream on Antelope Creek from Hogback Reservoir; it would be larger and would lie in a portion of the Tehama deer range administered by the Department of Fish and Game. Savercool is a smaller reservoir lying at an elevation of 2,400 feet in the Mill Creek drainage. This reservoir would be the most inaccessible of the group. Web Hollow and Forks of Butte Reservoirs are in the southern portion of the area in this study, in Big Chico and Big Butte Creeks respectively, in steep-sided, well-timbered canyons. All of these reservoirs have varying amounts of existing fishing and hunting use as well as minor amounts of other recreation activities. This existing use and projected existing use has been subtracted from the predicted recreation use to arrive at the net recreation use for these reservoirs.

All of these potential reservoirs are lacking in lands suitable for recreation development and are generally less accessible than the previously discussed reservoirs. Their relative locations are depicted on Plate No. 1.

Table 19

CROWN RESERVOIR

ESTIMATED CAPITAL, OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	(av. annual)	Capital Cost $5/new V. D.	Operation & Maintenance at 30¢/V. D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	17,000	$ 85,000	$ 51,000	$ 30,000	$ 81,000
2	27,000	50,000	81,000	48,000	129,000
3	39,000	60,000	117,000	69,000	186,000
4	54,000	75,000	162,000	95,000	257,000
5	71,000	85,000	213,000	125,000	338,000
6	90,000	95,000	270,000	158,000	428,000
7	112,000	110,000	336,000	197,000	533,000
8	136,000	120,000	408,000	239,000	647,000
9	163,000	135,000	489,000	286,000	775,000
10	192,000	145,000	576,000	337,000	913,000

Table 20

FACHT RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Use	Use Without Project	Net Use
1 (1970-80)	9,000	1,000	8,000
2	14,000	1,000	13,000
3	20,000	2,000	18,000
4	27,000	3,000	24,000
5	36,000	4,000	32,000
6	45,000	5,000	40,000
7	56,000	6,000	50,000
8	68,000	7,000	61,000
9	81,000	8,000	73,000
10	96,000	10,000	86,000

Table 21

FACHT RESERVOIR

ESTIMATED CAPITAL, OPERATION, MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Capital Cost $5/new V.D.	Operation & Maintenance at 30¢/V.D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	9,000	$ 45,000	$ 27,000	$ 16,000	$ 43,000
2	14,000	25,000	42,000	25,000	67,000
3	20,000	30,000	60,000	36,000	96,000
4	27,000	35,000	81,000	48,000	129,000
5	36,000	49,000	108,000	64,000	172,000
6	45,000	45,000	135,000	80,000	215,000
7	56,000	55,000	168,000	99,000	267,000
8	68,000	65,000	204,000	122,000	326,000
9	81,000	65,000	243,000	145,000	388,000
10	96,000	75,000	288,000	171,000	459,000

Table 22

FORKS OF BUTTE RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Use	Use Without Project	Net Use
1 (1970-80)	4,000	400	3,600
2	7,000	500	6,500
3	10,000	800	9,200
4	14,000	1,000	13,000
5	18,000	1,000	17,000
6	23,000	2,000	21,000
7	28,000	2,000	26,000
8	34,000	3,000	31,000
9	41,000	3,000	38,000
10	48,000	4,000	44,000

Table 23

FORKS OF BUTTE RESERVOIR

ESTIMATED CAPITAL, OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Capital Cost $5/new V. D.	Operation & Maintenance at 30¢/V. D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	4,000	$ 20,000	$ 12,000	$ 7,000	$ 19,000
2	7,000	15,000	21,000	12,000	33,000
3	10,000	15,000	30,000	17,000	47,000
4	14,000	20,000	42,000	24,000	66,000
5	18,000	20,000	54,000	31,000	85,000
6	23,000	25,000	69,000	39,000	108,000
7	28,000	25,000	89,000	47,000	131,000
8	34,000	30,000	102,000	58,000	160,000
9	41,000	35,000	123,000	70,000	193,000
10	48,000	35,000	144,000	82,000	226,000

Table 24

HOGBACK RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Use	Use Without Project	Net Use
1 (1970-80)	3,000	500	2,500
2	5,000	800	4,200
3	8,000	1,000	7,000
4	11,000	2,000	9,000
5	14,000	2,000	12,000
6	18,000	3,000	15,000
7	22,000	3,000	19,000
8	27,000	4,000	23,000
9	33,000	5,000	28,000
10	38,000	6,000	32,000

Table 25

HOGBACK RESERVOIR

ESTIMATED CAPITAL, OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Capital Costs $5/new V. D.	Operation & Maintenance at 30¢/V. D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	3,000	$ 15,000	$ 9,000	$ 5,000	$ 14,000
2	4,000	5,000	12,000	7,000	19,000
3	6,000	10,000	18,000	11,000	29,000
4	8,000	10,000	24,000	14,000	38,000
5	11,000	15,000	33,000	19,000	32,000
6	18,000	20,000	54,000	32,000	86,000
7	22,000	20,000	66,000	39,000	105,000
8	27,000	25,000	81,000	47,000	128,000
9	33,000	30,000	99,000	58,000	157,000
10	38,000	25,000	114,000	67,000	181,000

Table 26

DEHAVEN RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Use	Use Without Project	Net Use
1 (1970-80)	3,000	100	2,900
2	4,000	100	3,900
3	6,000	200	5,800
4	8,000	300	7,700
5	11,000	400	10,600
6	14,000	500	13,500
7	17,000	600	16,400
8	20,000	700	19,300
9	24,000	800	23,200
10	29,000	1,000	28,000

Table 27

DEHAVEN RESERVOIR

ESTIMATED CAPITAL, OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Capital Cost $5/new V. D.	Operation & Maintenance at 30¢/V. D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	3,000	$ 15,000	$ 9,000	$ 5,000	$ 14,000
2	4,000	5,000	12,000	7,000	19,000
3	6,000	10,000	18,000	11,000	29,000
4	8,000	10,000	24,000	14,000	38,000
5	11,000	15,000	33,000	19,000	32,000
6	14,000	15,000	42,000	25,000	67,000
7	17,000	15,000	51,000	30,000	81,000
8	20,000	15,000	60,000	35,000	95,000
9	24,000	20,000	72,000	42,000	114,000
10	29,000	25,000	87,000	51,000	138,000

Table 28

WEB HOLLOW RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

Decade	Use	Use Without Project	Net Use
1 (1970-80)	2,000	500	1,500
2	3,000	800	2,200
3	4,000	1,000	3,000
4	5,000	2,000	3,000
5	7,000	2,000	5,000
6	9,000	3,000	6,000
7	11,000	3,000	8,000
8	14,000	4,000	10,000
9	16,000	5,000	11,000
10	19,000	6,000	13,000

Table 29

WEB HOLLOW RESERVOIR

ESTIMATED CAPITAL, OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Capital Cost $5/new V. D.	Operation & Maintenance at 30¢/V. D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	2,000	$ 10,000	$ 6,000	$ 4,000	$ 10,000
2	3,000	5,000	9,000	5,000	14,000
3	4,000	5,000	12,000	7,000	19,000
4	5,000	5,000	15,000	9,000	24,000
5	7,000	10,000	21,000	12,000	33,000
6	9,000	10,000	27,000	16,000	43,000
7	11,000	10,000	33,000	19,000	52,000
8	14,000	15,000	42,000	25,000	67,000
9	16,000	10,000	48,000	28,000	76,000
10	19,000	15,000	57,000	33,000	90,000

Table 30

SAVERCOOL RESERVOIR

ESTIMATED RECREATION USE VISITOR DAYS
(Average Annual)

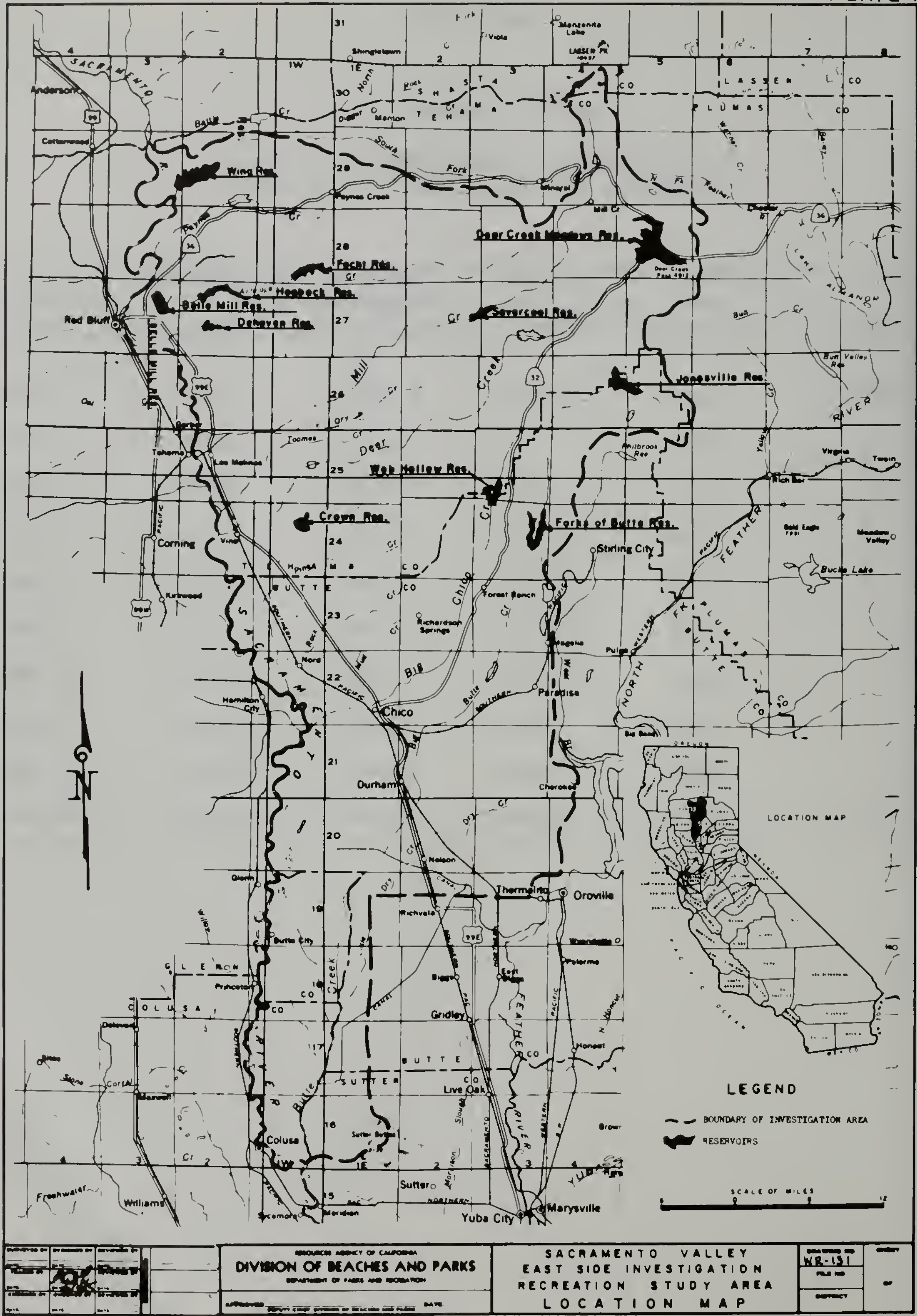
Decade	Use	Use Without Project	Net Use
1 (1970-80)	1,000	300	700
2	1,000	500	500
3	2,000	800	1,200
4	3,000	1,000	2,000
5	4,000	1,000	3,000
6	5,000	2,000	3,000
7	6,000	2,000	4,000
8	7,000	3,000	4,000
9	8,000	3,000	5,000
10	10,000	4,000	6,000

Table 31

SAVERCOOL RESERVOIR

ESTIMATED CAPITAL, OPERATION,
MAINTENANCE, AND REPLACEMENT COSTS BY DECADE

Decade	Visitor Days (av. annual)	Capital Cost $5/new V. D.	Operation & Maintenance at 30¢/ V.D.	Replacement at 3½% Capital inv.	Total OM&R
1 (1970-80)	1,000	$ 5,000	$ 3,000	$ 2,000	$ 5,000
2	1,000	-	3,000	4,000	7,000
3	2,000	5,000	6,000	8,000	14,000
4	3,000	5,000	9,000	13,000	22,000
5	4,000	5,000	12,000	20,000	32,000
6	5,000	5,000	15,000	29,000	44,000
7	6,000	5,000	18,000	40,000	58,000
8	7,000	5,000	21,000	52,000	73,000
9	8,000	5,000	24,000	66,000	90,000
10	10,000	10,000	30,000	84,000	114,000


Anderson
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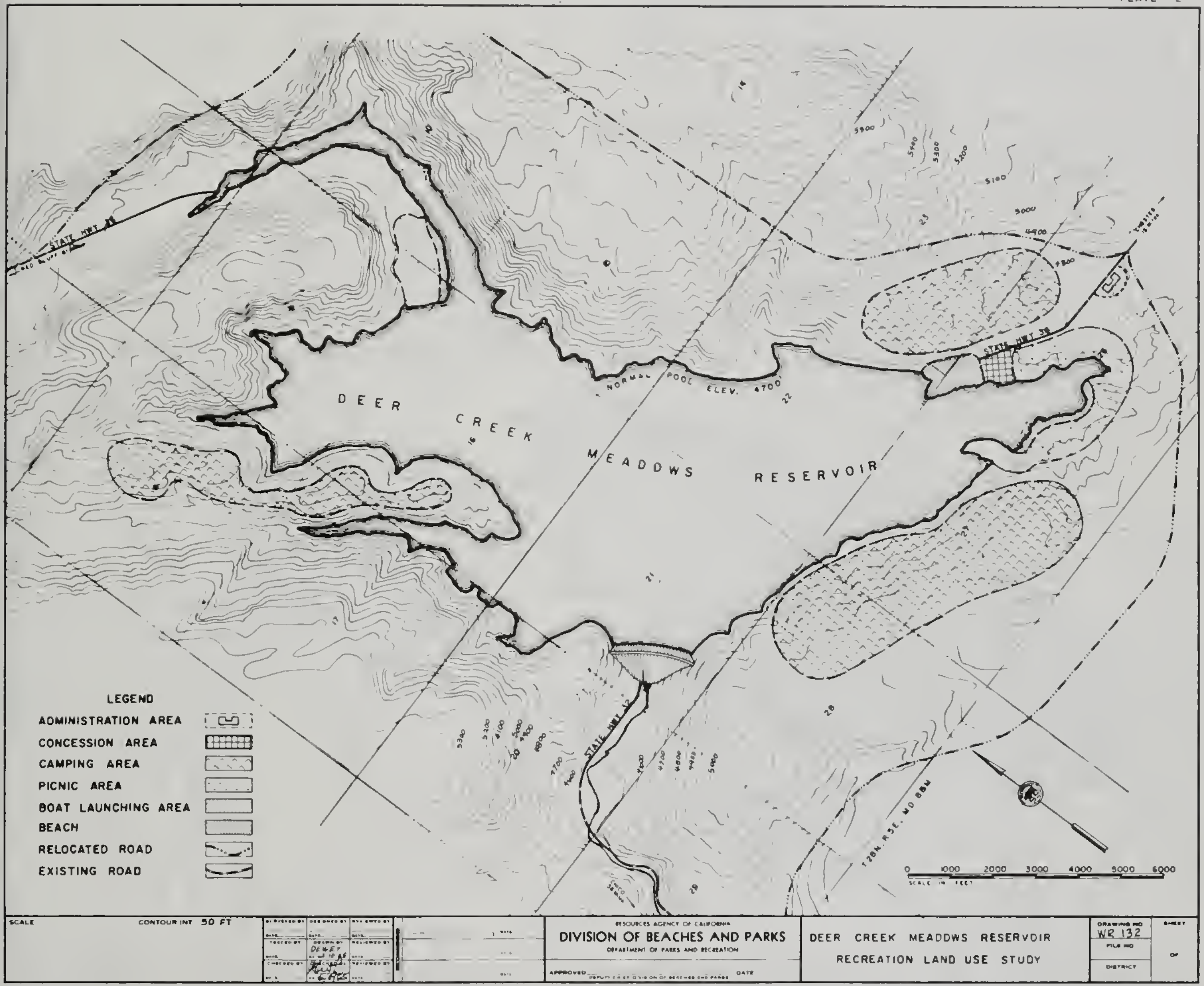
Wing Res.
Payne's Creek
Fecht Res.
Hoegbeck Res.
Belle Mill Res.
Red Bluff
Dehaven Res.
Shingletown
Manton
Mineral
Mill Cr
Deer Creek Meadows Res.
Sevencoal Res.
Jonesville Res.
Chester
Philbrook Res.
Web Hollow Res.
Crown Res.
Forks of Butte Res.
Stirling City
Forest Ranch
Tehama
Los Molinos
Corning
Vina
Kirkwood
Richardson Springs
Nord
Hamilton City
Chico
Paradise
Magalia
Durham
Cherokee
Nelson
Glenn
Richvale
Thermalito
Oroville
Butte City
Biggs
Princeton
Gridley
Palermo
Live Oak
Colusa
Sutter
Yuba City
Marysville
Williams
Freshwater
Maxwell
Sycamore
Meridian
Rich Bar
Virginia
Twain
Bucks Lake
Meadow Valley
LASSEN
PLUMAS
SHASTA
TEHAMA CO
BUTTE CO
GLENN
COLUSA
SUTTER
SACRAMENTO RIVER
FEATHER RIVER
LOCATION MAP
LEGEND
BOUNDARY OF INVESTIGATION AREA
RESERVOIRS
SCALE OF MILES
0 4 8 12
DIVISION OF BEACHES AND PARKS
DEPARTMENT OF PARKS AND RECREATION
SACRAMENTO VALLEY
EAST SIDE INVESTIGATION
RECREATION STUDY AREA
LOCATION MAP
WR-131

PLATE 2


DEER CREEK MEADOWS RESERVOIR
NORMAL POOL ELEV. 4700
STATE HWY 32
STATE HWY 36
LEGEND
ADMINISTRATION AREA
CONCESSION AREA
CAMPING AREA
PICNIC AREA
BOAT LAUNCHING AREA
BEACH
RELOCATED ROAD
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RESOURCES AGENCY OF CALIFORNIA
DIVISION OF BEACHES AND PARKS
DEPARTMENT OF PARKS AND RECREATION
APPROVED
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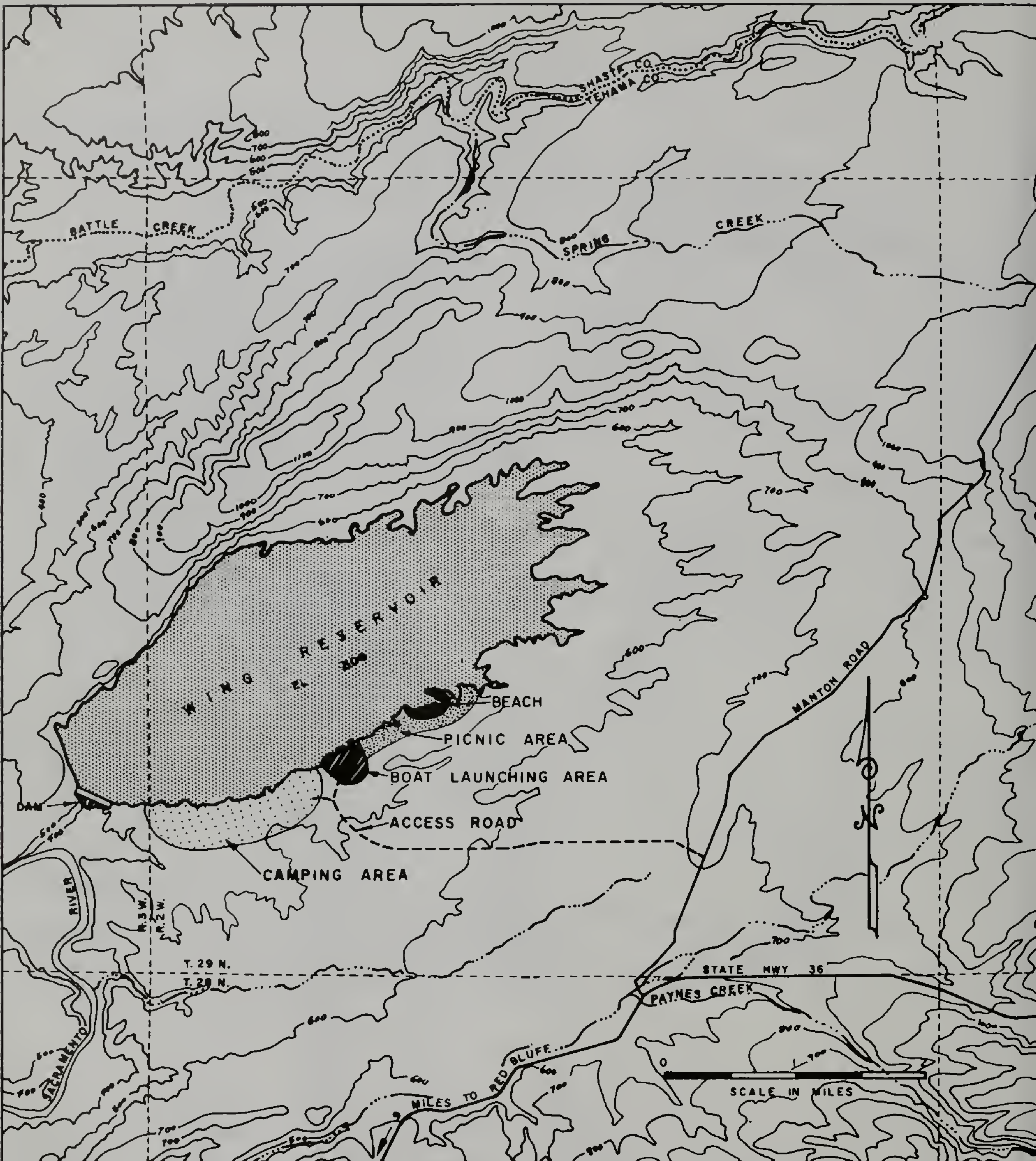
PLATE 3



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DIVISION OF BEACHES AND PARKS
DEPARTMENT OF PARKS AND RECREATION

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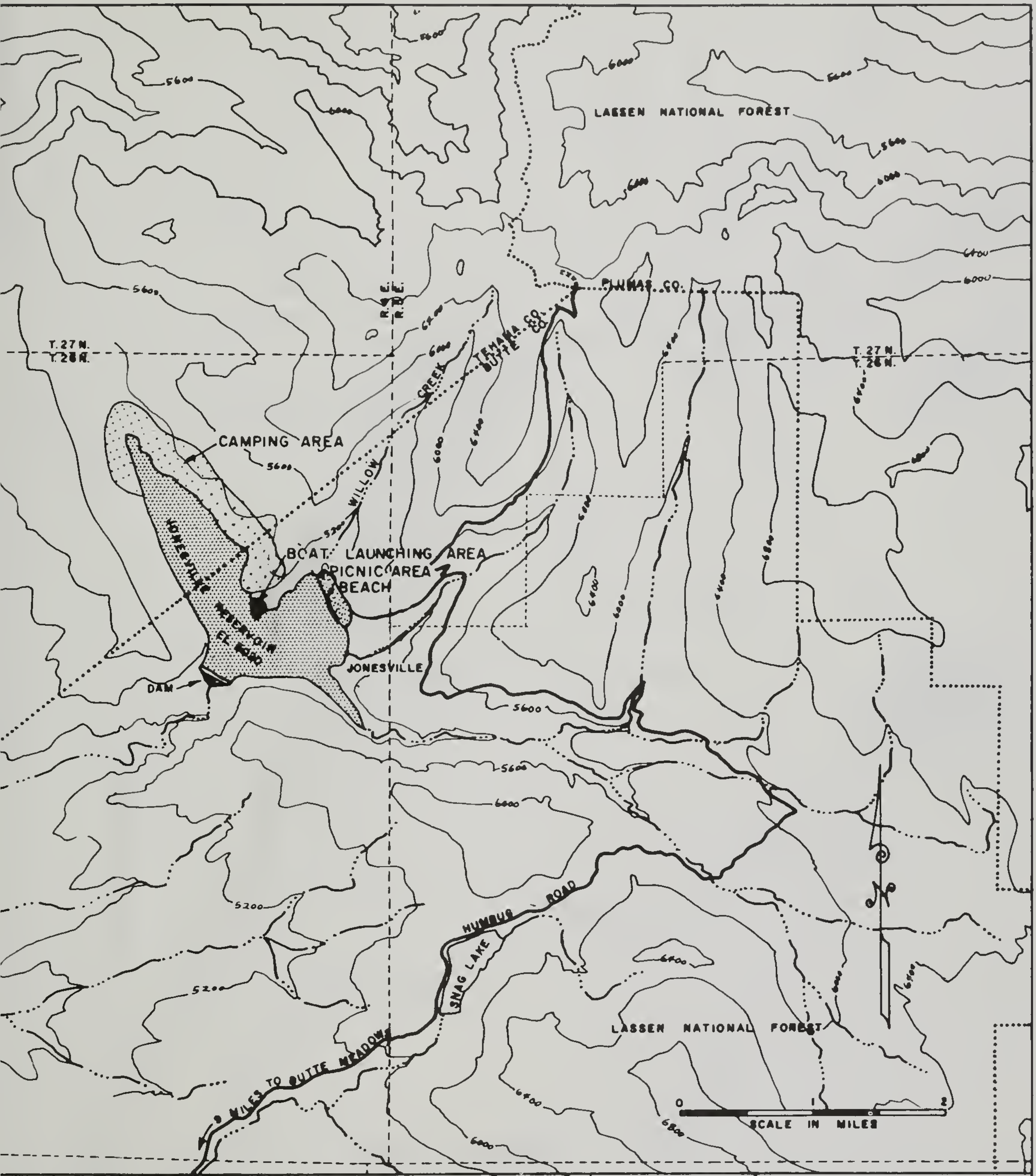

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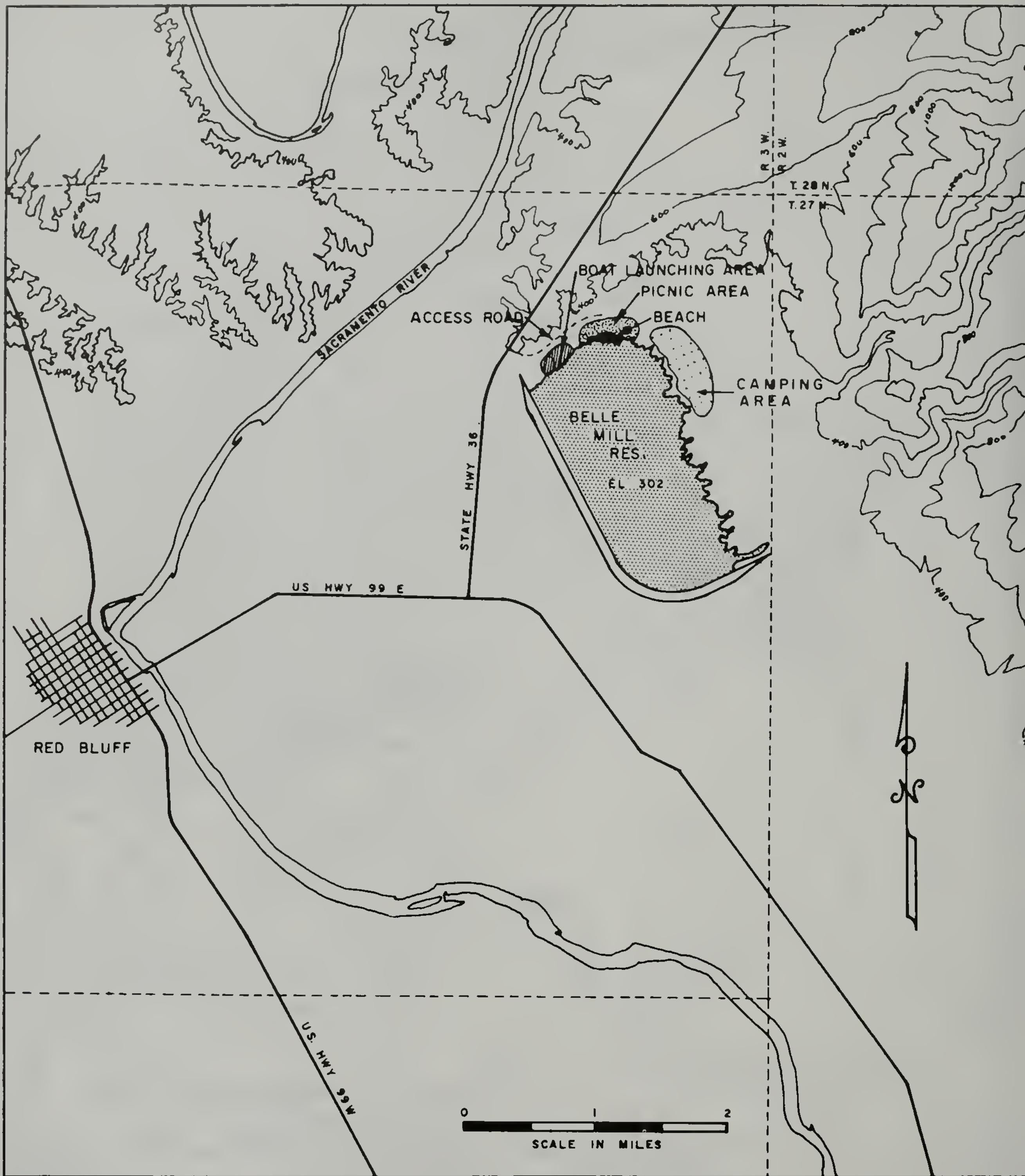
PLATE 5



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DIVISION OF BEACHES AND PARKS
DEPARTMENT OF PARKS AND RECREATION

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RECREATION LAND USE STUDY

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Appendix C

FISH AND WILDLIFE

By

Department of Fish and Game

State of California

THE RESOURCES AGENCY

Department of Water Resources

BULLETIN No. 137

SACRAMENTO VALLEY EAST SIDE INVESTIGATION

Appendix C

Fish and Wildlife

By

Department of Fish and Game

Water Projects Branch

Contract Services Section

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(Plates are bound at the end of the report.)

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

RONALD REAGAN, Governor

NORMAN B. LIVERMORE, JR., Administrator, The Resources Agency of California

WALTER T. SHANNON, Director, Department of Fish and Game

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WATER PROJECTS BRANCH

J. C. Fraser . . . . Branch Chie

This report was prepared under
the direction
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by

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Carl E. Lindquist . . . . Wildlife Manager II

February 1967

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CHAPTER 1. INTRODUCTION

The Sacramento Valley East Side Investigation area encompassed approximately 2,000 square miles in the northeastern part of California's Central Valley. Major streams within the study area included Antelope, Mill, Deer, Chico, and Butte Creeks.

A large portion of the foothill area is pristine and remains such as it was when inhabited by the Yahi Indians. Remnants of abandoned homesteads are scattered throughout the foothills as mute evidence of hardy pioneers who ran cattle and sheep in the area. Vast areas of the lower foothills are inaccessible except on foot or by four-wheel-drive vehicle. The area includes some of the most wild and rugged country in the State.

Partially because of the wilderness condition, the investigation area supports a variety of fish and wildlife. Soaring eagles, a species relatively intolerant to human encroachment, are frequently observed. Spring-run salmon, leaping against the rapids and cascades, are a sight to remember. Evidence of the large deer migrations between the high summer range and the winter range in the foothills is etched into the landscape. Many other forms of fish and wildlife are common in the area.

The southernmost portion of the investigation area, the Butte Basin, includes some of the best waterfowl habitat in the United States. Significant portions of the birds of the Pacific Flyway utilize that habitat. The rate at which lands are being reclaimed and the dwindling supply of good wetland habitat in other areas makes this habitat one of the most valuable assets of the entire investigation area. Land values in the heart of the duck club areas will support that fact.

The purposes of this reconnaissance report are to describe the effects of possible future water development projects upon these fish and wildlife resources and to recommend measures to preserve and enhance fish and wildlife with construction of these projects.

Authority

The Sacramento Valley East Side Investigation was proposed by the Department of Water Resources and approved by the California Legislature. The purposes of the investigation were to study the area's water supply and water needs and to determine how these needs could be met most economically. The investigation began in July 1961 and was completed in June 1966.

Fish and wildlife studies were conducted by the Contract Services Section of the Water Projects Branch, California Department of Fish and Game. Specific authorization was included in four Interagency Agreements between the Department of Water Resources and the Department of Fish and Game.

Objectives and Scope

The objectives of the fish and wildlife investigations were: (1) to provide an inventory of the fish and wildlife resources of the area, (2) to determine the effects of possible water development projects upon fish and wildlife; and (3) to recommend plans for preserving and enhancing these resources.

The scope of these studies varied from cursory examinations where few fish and wildlife resources were involved to rather detailed studies where important fish and wildlife populations would be affected by a project. Particular attention was paid to projects which appeared to be suitable for near future construction.

Related Fish and Wildlife Investigations

The results of several prior fish and wildlife investigations were utilized during this study. These included:

1) Studies by the U. S. Fish and Wildlife Service on Deer Creek as part of the "Shasta Salvage Plan",

2) Studies by the U. S. Fish and Wildlife Service on Mill Creek and the North Fork of Mill Creek to determine the advantages of flow stabilization in salmon spawning areas,

3) Annual king salmon spawning stock surveys by the Department of Fish and Game,

4) Studies on the Tehama Winter Deer Range by the Department of Fish and Game,

5) Annual waterfowl inventories by the U. S. Fish and Wildlife Service and the Department of Fish and Game,

6) Annual hunter surveys and estimated wildlife harvest by the Department of Fish and Game.

Statewide Significance of Fish and Wildlife in the Area

The fish and wildlife resources inhabiting the Sacramento Valley East Side Investigation area are important to the economy of the study area as well as other areas in the State. Common migratory species include salmon, steelhead, deer, mourning doves, bandtailed pigeons, and waterfowl. The area also supports important resident species of fish and wildlife.1/

Spring-run King Salmon

Prior to the advance of civilization into the fertile Central Valley of California, spring-run king salmon were probably the most abundant anadromous salmonid entering the Sacramento--San Joaquin River System. In a little over 100 years, civilization has almost succeeded in destroying this splendid race of salmon in California's Central Valley. Only remnants of the once abundant populations remain. Spring-run salmon have been totally eliminated from the San Joaquin River System by large dams on the Mokelumne, Toulumne, Merced, Stanislaus, and San Joaquin Rivers. With the accelerated expansion of water developments in the Sacramento System and the Sacramento--San Joaquin Delta, spring-run salmon in the Central Valley are threatened with extirpation.

1/ Common and scientific names for fish and wildlife species mentioned in the text are tabulated at the beginning of Chapter 3.

Much of the difficulty in preserving spring-run salmon is connected with their critical habitat requirements. Generally, they pass through the Delta during March, April, and May on their upstream migration. Many migrate to the spring-fed headwaters of larger streams, usually reaching those areas by June or July. Others spend the summer in the Sacramento River near Redding. During their upstream migration, they are in prime condition, extremely vigorous, and ardently sought by salmon anglers. After reaching the headwaters, they spend the summer in cold, deep pools in a state of semi-hibernation, protected by stream closures. Water temperatures in the holding pools seldom exceed 70 degrees F. Spawning usually begins in mid-September and continues through October. Unlike other races of king salmon which generally move seaward upon hatching, many young spring-run salmon spend their first summer near their birthplace before migrating to the ocean.

In the Sacramento River System, spring-run fish are essentially limited to the main stem Sacramento River, the Feather River, and Battle, Antelope, Mill, Deer, Big Chico, and Butte Creeks. A few spring-run salmon enter Cow and Cottonwood Creeks; however, it is doubtful if any survive to spawn. Although spring-run salmon formerly entered the Yuba and American Rivers, those runs are now extinct. The fate of spring-run salmon in the Feather River is uncertain because of limited holding area below the Oroville Fish Barrier Dam. Slater (1963)[2/] pointed out the danger of inter-racial hybridization in the Sacramento River. That danger could also manifest itself in the Feather River unless remedial measures are taken. The spring-run salmon in east side streams isolate themselves from fall-run fish during the spawning season, eliminating the danger of hybridization. Thus, the role of the Sacramento Valley East Side tributaries in preserving spring-run salmon is a very important one.

Attempts to transfer a portion of the spring-run salmon from the Sacramento River to Deer Creek, as part of the Shasta Salvage Plan, were largely ineffective. The carrying capacity of the creek was only slightly increased by laddering the lower Deer Creek falls. Stress factors resulting from hauling and high water temperatures were also detrimental. Between 1943 and 1946, a total of 15,052 spring-run salmon

2/ Names and publications cited in the text are listed in the Bibliography.

was transferred from the Sacramento River at Keswick Dam to Deer Creek (Moffett, 1949). Counts made at Stanford-Vina Dam in 1963 and 1964 indicated that the spring-run in Deer Creek has declined since the mid-forties when partial counts were made (Fry, 1961).

The limited knowledge available indicates that an average of about 25,000 spring-run salmon enter the Sacramento River System annually. Over one-third of these are dependent upon streams included in this investigation area, primarily Mill, Deer, and Butte Creeks.

Spring-run salmon have a high esthetic and scientific value that should be preserved. Any project which involves their habitat should be designed so it does not endanger the race in any way. Although their commercial importance is relatively small when compared to the larger numbers of fall-run salmon, every effort must be made to prevent the disappearance of this fine sport fish from the Central Valley.

Steelhead Trout

The steelhead trout, an important and highly prized sport species, is also dependent upon essential habitat provided by streams included in this investigation area. An estimated 25 percent of the steelhead migrating into the upper Sacramento River spawn in Antelope, Mill, and Deer Creeks.

Studies by Hallock, (op. cit.), indicated that annual migrations of naturally produced steelhead past Fremont Weir into the upper Sacramento River averaged about 18,000 fish between 1953 and 1959. Creel censuses by the Department of Fish and Game revealed that roughly 8,000 or 45 percent were taken by anglers. Steelhead fishermen averaged about 21,500 angler-days annually.

Anglers from essentially every part of California come to the upper Sacramento River System to fish for steelhead. Up to 11 percent are from the San Francisco Bay and Delta areas (Hallock, op. cit.).

Most steelhead fishing in the upper Sacramento River System is done on riffles in the main river. Conversely, most of the spawning occurs in tributaries to the river. Almost any tributary development could directly affect the resource.

The construction of Shasta Dam resulted in the loss of much steelhead spawning area in the Sacramento River drainage. On the other hand, larger and cooler summer flows now in the river are very conducive to rearing juvenile steelhead. An excellent year-round rainbow-steelhead trout fishery has developed in the river between Keswick Dam and Chico.

The amount of angling effort expended in the steelhead fishery may be related to the abundance of fish. Smith (1950) estimated that the 1948-49 steelhead angling effort on the upper Sacramento River amounted to about 43,200 angler-days. The greatest annual effort estimated between 1954 and 1959 (Hallock,op. cit.) was 27,552 angler-days. Subtle tributary habitat losses may have contributed to a reduction in steelhead populations and, consequently, the angling effort. The effects of further losses of habitat become obvious.

Fall-run King Salmon

Historically, the larger east side streams, such as Mill and Deer Creeks, probably supported fairly large numbers of fall-run king salmon. With the increasing needs for agricultural water and subsequent diversions, these runs have dwindled; however, the potential still exists if the shortage of water can be overcome during critical months.

In 1952, the U. S. Fish and Wildlife Service estimated a combined spawning escapement in Mill and Deer Creeks of 26,000 fall-run salmon. Department of Fish and Game estimates of fall-run salmon spawning in the two creeks in 1959 totaled only 850 fish. Although the runs have recovered to some extent, they remain far below those of the early fifties. The 1955 flood may have been instrumental in reducing the 1959 run.

The Tehama Deer Herd

The Tehama blacktailed deer range covers portions of four counties. The majority of lands within this range are open to public hunting. The herd provides an estimated five percent of the statewide deer kill.

For the most part, the herd is migratory. They spend the summer in the high country in the Lake Almanor-Lassen Park vicinity with a few going eastward almost to Eagle Lake. Winters are spent in the foothills a few miles east of Red Bluff. The deer concentrate during the migration and follow established migration routes in large numbers. Hunting from blinds along some of these routes is popular in this area. Much of the hunting occurs toward the end of the season when deer enter the winter range.

Migratory Waterfowl

Loss of habitat is the most critical factor affecting California wildlife. Waterfowl populations, dependent of wetlands to support them, face a continuing loss of habitat. According to the California Fish and Wildlife Plan (1965), wetlands have dwindled from about 3,500,000 acres to 418,000 acres. Continued losses will be virtually impossible to replace. A large portion of the remaining wetlands acreage is in privated duck clubs and other private lands. Landowners are subjected to economic pressures brought about by reclamation and flood control projects. Because of high investments in lands, taxes and water, an estimated 20 percent of the areas operated as private duck clubs will be lost by 1980, directly reducing wetlands habitat. California is the primary wintering grounds for waterfowl of the Pacific Flyway and habitat losses here will directly affect waterfowl hunting in the entire flyway.

Butte Basin is one of the few remaining naturally-flooded basins in California that is not completely reclaimed. The basin is one of the most valuable segments of the remaining wetlands habitat, and every effort must be made to conserve and perpetuate it. Losses of critically important wetland habitat here could contribute to an increase in depredations problems that are now under reasonable control.

CHAPTER 2. STREAM DESCRIPTION

The following sections briefly describe the physiography and hydrology of each stream and existing water developments. Low summer flows and, when available, maximum water temperatures are stressed because these factors play important roles in determining the suitability of streams for salmonid production. Existing water developments are described because some of them present serious problems for anadromous fishes.

The major drainages within the investigation area are of volcanic origin. Permanent springs are common at higher elevations and summer flows in larger streams are sustained at a fairly high level. The major drainages are similar in that they originate at high elevations, flow through coniferous forest, then through deep canyons before reaching the valley floor and the Sacramento River (Figure 1).

Antelope Creek

The three main branches of Antelope Creek originate on the slopes of Turner Mountain (Tehama County), at elevations of about 6,000 feet. The North Fork begins at Pear Lake, the Middle Fork originates at Diamond Lake, and the South Fork begins near Belfast Meadows. Sixteen miles below its origin, the South Fork joins the North Fork to form Antelope Creek. About 28 miles below the confluence, the stream enters the Sacramento River below Red Bluff. With the exception of the lower five miles, Antelope Creek flows through a fairly deep canyon. After the creek reaches the valley floor, it splits into several channels to transport water to the river during high flow periods.

Streamflow records were available for the U. S. Geological Survey gaging station - Antelope Creek near Red Bluff. Flows were computed for Antelope Creek at Facht damsite by the Department of Water Resources. August and September flows at the U.S.G.S. gage

Figure 1. Typical views of East Side Streams

Headwaters

Canyon

Valley Floor

average about 35 cubic feet per second. Summer accretions between Facht damsite and the gage average less than two cfs. Annual precipitation within the drainage varies from about 45 inches at the headwaters to 20 inches near the mouth. Water temperature data were not collected on Antelope Creek; however, stream temperatures at the stream gage probably exceed 70 degrees Fahrenheit frequently during the summer.

Two diversion dams exist on Antelope Creek. The City of Red Bluff owns a dam in Section 9, T27N, R2W. A new fishway was constructed over the dam in 1960. The other dam, owned by the Coneland Water Company, is located in Section 18, T27N, R2W, and is used for diverting irrigation water. No fishway has been provided over the dam; however, fish can pass at most flows.

Mill Creek

Mill Creek has its origin on the south slopes of Mt. Lassen in eastern Tehama County. The creek drops from an elevation of about 8,000 feet at its headwaters to 195 feet where it joins the Sacramento River, roughly one mile north of the town of Tehama. About 52 miles of the 60-mile stream lies in an entrenched canyon bordered by steep lava and basalt cliffs. Mill Creek generally flows in a southwesterly direction, and is relatively inaccessible except by trail. After leaving the canyon, Mill Creek flows eight miles across the Sacramento Valley floor.

Runoff data were available for the U.S.G.S. gaging station--Mill Creek near Los Molinos. Additional flows were computed for Mill Creek near Mineral[1/] and Mill Creek near Big Bend by the Department of Water Resources. Mean August and September flows at those points were 30 cfs near Mineral, 60 cfs near Big Bend, and 100 cfs near Los Molinos.

Mean annual precipitation varies greatly within the drainage area, ranging from about 90 inches on Diamond Peak to approximately 20 inches at the mouth of the creek. Good snowpacks in the headwater area are responsible for sustaining high streamflows through June.

1/ The U. S. Geological Durvey maintained a stream gaging station near Mineral from 1928 through 1932.

Stream temperatures were monitored with continuous-recording thermographs at four points along the creek as part of this investigation (Hayes, 1965). Temperatures were recorded at the Highway 36 crossing, Black Rock, the mouth of Little Mill Creek, and Clough Dam. Maximum temperatures observed at each station were: 72° at the Highway 36 crossing, 65° at Black Rock, 70° at the mouth of Little Mill Creek, and 74° at Clough Dam.

Mill Creek differs from other east side streams because it is turbid during the spring snowmelt period. The turbidity is caused by volcanic ash which is common in the headwaters.

Three irrigation dams exist on Mill Creek. The Los Molinos Mutual Water Company Dam is located in Section 1, T25N, R2W, and serves valley lands to the north. Clough Dam is located in Section 36, T26N, R2W and Ward's Dam is in Section 3, T25N, R2W. Both Clough Dam and Ward's Dam serve agricultural lands south of Mill Creek. Clough Dam, the highest of the three, is approximately 15 feet high. The others are considerably lower; however, all three have been provided fishways. The entire summer flow of Mill Creek is diverted at these dams. Above the valley floor, Mill Creek has not been developed and remains in a relatively unspoiled condition.

Deer Creek

Deer Creek emanates from the east side of Butt Mountain at an elevation of approximately 7,100 feet. From there it descends rapidly to the upper end of Deer Creek Meadows where it is joined by Lost Creek from the north. Lost Creek drains Wilson Lake, the elevation of which is 5,267 feet. Gurnsey Creek enters Deer Creek in Deer Creek Meadows. Below that point, the creek flows through a deep canyon and generally parallels Mill Creek until it reaches the Sacramento Valley. Deer Creek enters the Sacramento River about one and one-half miles north of Squaw Hill. About 12 miles of the 60-mile stream lies within the valley.

Long-term hydrological data were available for the U.S.G.S. gaging station--Deer Creek near Vina. Computed flows were available for Deer Creek at Deer Creek Meadows, at Polk Springs,[2] and at Sugarloaf damsite. Average August and September flows were 30 cfs at Deer Creek Meadows, 81 cfs at Sugarloaf damsite, 86 cfs at Polk Springs, and 93 cfs near Vina.

Mean annual precipitation ranges from 70 inches near Wilson Lake to about 20 inches near the mouth of the creek. Spring flows in Deer Creek are not sustained as well as those in Mill Creek because the drainage receives less snowpack. Average June flows at the U.S.G.S. gage on Mill Creek near Los Molinos are about 300 cfs while those at the U.S.G.S. gage on Deer Creek near Vina are about 200 cfs.

Stream temperatures were measured with thermographs at Deer Creek Meadows, Ponderosa Way, the mouth of Rock Creek, Hobson Camp, and Stanford-Vina Dam (Hayes, op. cit.). Maximum stream temperatures were usually reached in July or August. Maximum temperatures recorded at each station were: 72° at Deer Creek Meadows, 70° at Ponderosa Way, 69° at the mouth of Rock Creek, 72° at Hobson Camp, and 82° at Stanford-Vina Dam.

Except for some small consumptive demands on Lost Creek, Deer Creek water is not developed until it reaches the valley floor. The first dam, located at the mouth of the canyon in Section 23, T25N, R1W, is owned and operated by the Deer Creek Irrigation District. The dam is a flashboard structure and diverts water to lands south of Deer Creek. The second dam is located on a meander channel in Section 33, T25N, R1W, and diverts a small quantity of water to the north. To divert low flows into that channel, a temporary earth dam is constructed each year in the vicinity of the power line crossing. The other dam on Deer Creek is Stanford-Vina Dam, owned by the Stanford-Vina Ranch Irrigation District, located in Section 1, T24N, R2W. The dam (Figure 2) is approximately 12 feet high and diverts irrigation water to the north and to the south. During years of average runoff, the entire summer flow of Deer Creek is diverted and the creek is dry below Stanford-Vina Dam from mid-June until the first storms of October.

2/ U.S.G.S. maintained gages at Deer Creek Meadows and at Polk Springs from 1928 to 1932 and installed a new gage near Slate Creek (three miles downstream from Deer Creek Meadows) in 1960.

Figure 2. Stanford-Vina Diversion Dam on Deer Creek

Big Chico Creek

Big Chico Creek originates at an elevation of approximately 5,700 feet on the slopes of Colby Mountain in eastern Tehama County. The 42-mile stream flows in a southwesterly direction to its confluence with the Sacramento River, approximately five miles west of the city of Chico. For the most part, the stream flows through a deep, shaded canyon and enters the Sacramento Valley about four miles northeast of Chico in Bidwell Park.

Hydrological data were available for two points within the drainage. Recorded flows were available from the U.S.G.S. gaging station -- Big Chico Creek near Chico. The Department of Water Resources computed flows for Big Chico Creek near Soda Springs.

August and September flows at Big Creek near Soda Springs average about ten cfs while those of Big Chico Creek near Chico average approximately 25 cfs. Precipitation within the drainage varies from over 50 inches at the headwaters to about 25 inches annually at Chico. The maximum water temperature recorded in Bidwell Park during the summer of 1964 was 78° and temperatures over 70° were common (Hayes, op. cit.).

Only one water development of any consequence exists on Big Chico Creek. The U. S. Corps of Engineers recently completed a flood control project east of Chico which diverts flood waters from Big Chico Creek into Lindo Channel and Mud Creek. One or two pump diversions for irrigation exist between Chico and the Sacramento River.

Butte Creek

Butte Creek originates as a number of small streams which drain Humboldt Peak and Humbug Summit in northeastern Butte County. Most of these small streams originate at elevations of approximately 6,500 feet. Generally, Butte Creek parallels Big Chico Creek to the vicinity of Chico. At that point, the creek leaves the canyon and enters the Sacramento Valley. About 12 miles south of Chico, the creek turns in a southerly direction and flows through the upper Butte Basin and the Butte Sink to its confluence with the Sacramento River about five miles downstream from the town of Colusa. During high-water periods in the Sacramento River, Butte Creek overflows into Butte Slough and the Sutter Bypass.

The Butte Basin, which is comprised of the upper Butte Basin and the Butte Sink, includes about 170,000 acres in Butte, Sutter, Glenn, and Colusa counties. The area serves as a natural overflow area for the Sacramento River when flows at Chico Landing exceed about 90,000 cfs. River water also enters the basin through Moulton and Colusa Weirs. Water from the east enters from Little Chico Creek, Butte Creek, and the Cherokee Canal. The Butte Sink (the lower Butte Basin) is a low area, lying northwest of the Sutter Buttes. It serves as a flood-water retention area with a capacity of about one million acre-feet. A large part of the sink is swamp or semi-swamp and provides some of the best waterfowl marshland in the United States (Figure 3).

Hydrological information was available for two points on Butte Creek. Recorded flow data were available for U.S.G.S. gaging stations near Chico and near Butte Meadows.[3/] August and September flows at Butte Meadows average approximately 60 cfs. Low flows at the U.S.G.S. gage near Chico are about 120 cfs. This includes about 40 cfs which is imported from the West Branch of the Feather River. Precipitation within the Butte Creek drainage area varies from approximately 70 inches per year at the headwaters to less than 20 inches at the mouth.

3/ U.S.G.S. gage near Butte Meadows was installed in August 1960. Historic flows for the period from 1921 to 1960 were computed by the Department of Water Resources.

Figure 3. Typical Marshlands in the Butte Sink

During 1961, water temperature data were collected on Butte Creek at Centerville Powerhouse and near the U.S.G.S. gage by the California Department of Fish and Game. The maximum water temperatures observed were 69° at Centerville and 74° near the gage (Hayes, op.cit.).

Butte Creek has been extensively developed by the Pacific Gas and Electric Company for power and by agricultural interests for irrigation water. Power development is restricted to the canyon area above Centerville. Two storage reservoirs, Magalia and Paradise, are located on Little Butte Creek. Both are owned by the Paradise Irrigation District.

A diversion dam near the mouth of Inskip Creek in Section 36, R3E, T25N, diverts water from Butte Creek to Desabla Forebay (Section 2, R3E, T25N). Desabla Forebay, which also receives import water from the West Branch of the Feather River, supplies water to Desabla Powerhouse. Shortly downstream from Desabla Powerhouse, water is diverted into a gravity canal which supplies water to Centerville Powerhouse (Section 5, R3E, T22N).

Below the mouth of Little Butte Creek, seven diversion dams have been constructed on Butte Creek. Several of the dams are demountable flashboard structures which are removed when water is not being diverted. This type of dam normally presents few problems to migrating salmonids when the flashboards are not in place.

Other Tributaries

Descriptions of Paynes, Inks, Salt, and Little Antelope Creek are brief. The streamflow of each is intermittent, or nearly so. Also, with the exception of Paynes Creek, their anadromous fisheries contributions are limited or non-existent.

Paynes Creek

Paynes Creek originates at Cold Creek Meadows at an elevation of 5,200 feet. Thirty-one miles below that point, Paynes Creek enters the Sacramento River about seven miles upstream from Red Bluff. Plum Creek a 12-mile tributary, joins Paynes Creek about 14 miles above the mouth. Records from the U.S.G.S. gaging station (Paynes Creek near Red Bluff) indicates that Paynes Creek is generally dry before the first of July. Occasionaly, the streamflow ceases in early June. A diversion dam about two miles above the mouth diverts water into a small reservoir in the Bend Area.

Inks Creek

Inks Creek, which lies between Paynes Creek and Battle Creek, has its origin on the west slope of Soap Butte at an elevation of 900 feet. The creek enters the Sacramento River about two miles below Jellys Ferry and is about eight miles in length. Flows at the mouth of Inks Creek were computed by the Department of Water Resources. Average annual runoff is only 11,000 acre-feet and the stream is frequently dry by the first of June. No important water developments exist on Inks Creek.

Salt Creek

Salt Creek is formed by a number of short tributaries which drain the area east of Tuscan Buttes. The largest tributary, Meeker Creek, originates at an elevation of 2,200 feet. Salt Creek enters New Creek, a distributary of Antelope Creek, approximately one mile from the Sacramento River. Hydrological data for Salt Creek were not available. Salt Creek is intermittent and highly mineralized. No water developments exist of Salt Creek.

Little Antelope Creek

Little Antelope Creek lies south of Antelope Creek and originates at Payne Spring Cabin (elevation 2,160 feet) about two miles west of Kingsley Cove. Eight miles below that point, it joins Cottonwood Creek, a nine-mile tributary. About ten miles below the mouth of Cottonwood Creek, Little Antelope Creek enters Antelope Creek. Little Antelope Creek is also intermittent for most of the summer. The creek has not been developed.

CHAPTER 3. EXISTING FISH AND WILDLIFE RESOURCES

The Sacramento Valley East Side area contains a wealth of fish and wildlife. Several species are migratory, spending only portions of their lives within the investigation area. These include salmon, steelhead, deer, mourning doves, bandtailed pigeons, and waterfowl. The area also includes a multitude of resident fish and wildlife species.

Fish Populations

The major streams within the area, Antelope, Mill, Deer, Big Chico, and Butte Creeks, support populations of salmon and steelhead. Upstream limits of salmon migrations are shown on Plate 1. Paynes Creek reportedly has a small steelhead run and occasionally a few fall-run salmon spawn in the lower reaches of the creek. Resident trout are found at higher elevations while warmwater fish occupy lower areas where conditions are favorable.

The fisheries within the creeks are predominatly directed toward resident trout and anadromous steelhead. The summer trout fishery starts in the lower ends of canyons and extends upstream to the headwaters. The steelhead fishery is restricted to the valley by regulations. The steelhead season extends from November 1 to February 28, although some steelhead are taken in October during the regular trout season.

The bulk of the salmon fishery occurs in the Pacific Ocean and the Sacramento River. Tributary streams north of Butte County are designated salmon spawning areas and are closed to salmon angling. In the upper Sacramento River, salmon and salmon fishermen congregate at the mouths of major tributaries such as Mill, Deer, and Battle Creeks. The fishery extends for several months of the year. A salmon fishing scene at the mouth of Deer Creek is shown in Figure 4.

Antelope Creek

Both fall and spring-run king salmon, as well as steelhead trout, utilize Antelope Creek for spawning and nursery area. Estimates of fall-runs between 1956 and 1963 ranged from 250 to 838 fish with an

TABLE 1

List of Common and Scientific Names of Fish and Wildlife Species Mentioned in this Report.

FISH

Common Name	Scientific name
King salmon	Oncorhynchus tshawytscha, (Walbaum)
Silver salmon	Oncorhynchus kisutch, (Walbaum)
Kokanee salmon	Oncorhynchus nerka, (Walbaum)
Steelhead trout	Salmo gairdnerii, Richardson
Rainbow trout	Salmo gairdnerii, Richardson
Brown trout	Salmo trutta, Linnaeus
Eastern brook trout	Salvelinus fontinalis, (Walbaum)
Largemouth bass	Micropterus salmoides, (Lacepede)
Smallmouth bass	Micropterus dolomieui, Lacepede
Bluegill	Lepomis macrochirus, Rafinesque
Black crappie	Pomoxis nigromaculatus, (Le Sueur)
Green sunfish	Lepomis cyanellus, Rafinesque
Tule perch	Hysterocarpus traskii, Gibbons
White catfish	Ictalurus catus, (Linnaeus)
Brown bullheads	Ictalurus nebulosus, (Le Sueur)
Squawfish	Ptychocheilus grandis, (Ayres)
Western suckers	Catostomus occidentalis, (Ayres)
Carp	Cyprinus carpio, Linnaeus

WILDLIFE

Columbia blacktailed deer	Odocoileus hemionus columbianus
Rocky Mountain mule deer	Odocoileus hemionus hemionus
Black bear	Ursus americanus
Mountain lion	Felis concolor
Feral pig	Sus sp.
Sierra grouse	Dendragapus obscurus
Mountain quail	Oreortyx picta
Valley quail	Lophortyx californica
Douglas squirrel	Tamiasciurus douglasii
Grey squirrel	Sciurus griseus
Mourning dove	Zenaidura macroura
Pheasant	Phasianus colchicus
Snowshoe rabbit	Lepus washingtonii
Cottontail rabbit	Sylvilagus audubonii
Brush rabbit	Sylvilagus bachmani
Jackrabbit	Lepus californicus
Ducks	Anatinae-Nyrocinae - several species
Geese	Anserinae - several species
Muskrats	Ondatra zibethica
Beavers	Castor canadensis
Songbirds	Several species
Bald eagles	Haliaeetus leucephalus
Golden eagles	Aquila chrysaetos

average annual run of approximately 500 fish. Fall-run fish restrict themselves primarily to the valley portion of the creek.

Spring-run salmon migrate considerably further upstream than fall-run fish. They have been observed by Van Woert (personal communication) as far upstream as McClure Place on the North Fork and have been reported as far upstream as Buck's Flat on the South Fork of Antelope Creek. Although no accurate population data are available, the run has been estimated to be about 500 fish annually.

Steelhead utilize a large portion of Antelope Creek for spawning and nursery area. The steelhead habitat is about the same as that for spring-run salmon. No population estimates are available; however, the run is thought to average about 300 fish.

Rainbow and brown trout inhabit the upper reaches of Antelope Creek. Each year, the Department of Fish and Game plants about 12,000 catchable-sized rainbow trout in Antelope Creek and its tributaries at the Ponderosa Way crossing. Trout are fairly abundant as far downstream

Figure 4. Salmon Fishing at the mouth of Deer Creek

as Facht Place. Smallmouth bass are abundant between Facht Place and the mouth of the canyon. Non-game fish such as squawfish, suckers, and carp are also present.

The anadromous fishes of Antelope Creek are faced with several problems. Fall-run salmon are usually confronted with low flows during the fall and winter. In addition, the quantity of good spawning gravel available below Coneland Water Company Dam is limited. A majority of the fall-run fish spawn between the Coneland Dam and Cone Grove Road. Adult fall-run salmon are occasionally attracted into and become stranded in the several channels below the Coneland Dam. These include New Creek, Butler Slough, and Antelope Creek. During high flows each of these streams may carry substantial quantities of water. Craig Creek carries the bulk of the flow after flood peaks subside.

Spring-run salmon and steelhead encounter other problems which include passage difficulties, screening problems, and low summer flows with correspondingly high temperatures. The Coneland Water Company Dam is not equipped with a fishway; however, fish can swim at all times except during very low or extremely high flows. No fish screens have been installed on ditches emanating from the dam. A new fishway over the Red Bluff water supply dam was completed in 1960. Unfortunately, the fishway apparently only operates when the pool behind the dam is full. The balance of the time, fish are expected to swim through a culvert in the dam.

Capacities for holding and rearing spring-run salmon and rearing steelhead within the canyon are limited by low flows and high temperatures. If temperatures and flows were suitable, large pools between Facht Place and the City of Red Bluff Dam would be ideal for holding adult spring-run salmon during the summer months.

<u>Mill Creek</u>

The anadromous fishes entering Mill Creek include fall-run and spring-run king salmon and steelhead trout. A few winter-run salmon spawn in the creek, but high temperatures probably preclude successful spawning unless it occurs above the valley floor. A fish-counting station was maintained on the fishway at Clough Dam from 1953 through

June 1964. The station provided essentially complete counts of spring-run salmon and steelhead during that period. That portion of the fall-run salmon spawning below the station were based upon carcass recovery surveys. Salmon and steelhead counts at Clough Dam, as well as estimates of fall-run salmon spawned below the dam are presented in Table 2.

Fall-run king salmon usually enter Mill Creek after the first autumn rain. Although a few move a short distance into the canyon, the bulk of them spawn within the valley. Estimates of the total spawning populations have ranged from almost 10,000 in 1953 to 840 in 1959, with an 11-year average of 3,500 fish. Counts over Clough Dam ranged from 3,744 in 1953 to 65 in 1959 and averaged 1,100 fish.

TABLE 2

Estimates and Counts of
Adult King Salmon and Steelhead in Mill Creek

Year	Counted at Clough Dam			Estimates of fall-spawners below Clough Dam 1/	Total fall-run salmon
	Steelhead	Spring-run salmon	Fall-run salmon		
1953-54	715	1,789	3,744	6,000	9,744
1954-55	1,492	2,967	2,901	4,000	6,901
1955-56	1,213	2,233	1,722	1,000	2,722
1956-57	1,433	1,203	131	750	881
1957-58	1,301	2,212	1,341	4,000	5,341
1958-59	790	1,580	1,140	3,200	4,340
1959-60	417	2,368	65	775	840
1960-61	742	1,245	66	800	866
1961-62	1,222	1,692	86	1,600	1,686
1962-63	2,269	1,315	786	3,600	4,368
1963-64	1,158	1,628	184	1,300	1,484

1/ Department of Fish and Game estimates based upon carcass recoveries.

Mill Creek has a fair number of spring-run salmon. Counts at Clough Dam have varied from 2,967 in 1955 to 1,203 in 1957 and averaged

1,839. Spring-run salmon begin their upstream migration in March and continue into July when flow conditions are favorable. One adult salmon was observed five miles above Black Rock during this study and an angler reported seeing salmon at Big Bend, three miles further upstream.

Steelhead trout are also fairly abundant in Mill Creek. Counts at Clough Dam ranged from 417 fish in 1959-60 to 2,269 in 1962-63. The run has averaged 1,160 fish during the 11-year period from 1953-54 through 1963-64. The actual upstream migration limit of steelhead is unknown; however, it is probably near the Highway 36 crossing.

Salmon and steelhead population trends in Mill Creek were determined by plotting running averages. These trends are illustrated in Figure 5. Steelhead populations appear to be relatively stable while the trend for fall-run salmon is definitely downward. Spring-run salmon averages indicate only a slight downward trend.

Migratory runs of adult squawfish and suckers from the Sacramento River enter Mill Creek to spawn. These migrations occur in the spring. Predation on young king salmon fry by adult squawfish may be significant.

Silver salmon are not native, but were introduced into the Sacramento Valley. Experimental plants of silver salmon were made in Mill Creek in 1956, 1957, and 1958. Eggs taken from adults in the Lewis River, Washington were hatched and the fish reared at the Department of Fish and Game's Darrah Springs Fish Hatchery on Battle Creek. A total of 145,000 yearlings were released and about 2,320 adults returned to Clough Dam. An almost equal number of adults returned to Coleman National Fish Hatchery also on Battle Creek. Although early results of the program were rather promising, subsequent returns failed to establish a run.

Between 1954 and 1959, the Department of Fish and Game conducted limited creel censuses on Mill and Deer Creeks as part of a steelhead planting evaluation program in the upper Sacramento River System. Those data did not provide estimates of the total effort, but did shed some light on the quality of the fishery. The average success was 0.3 fish per angler-day or about three days of fishing for each

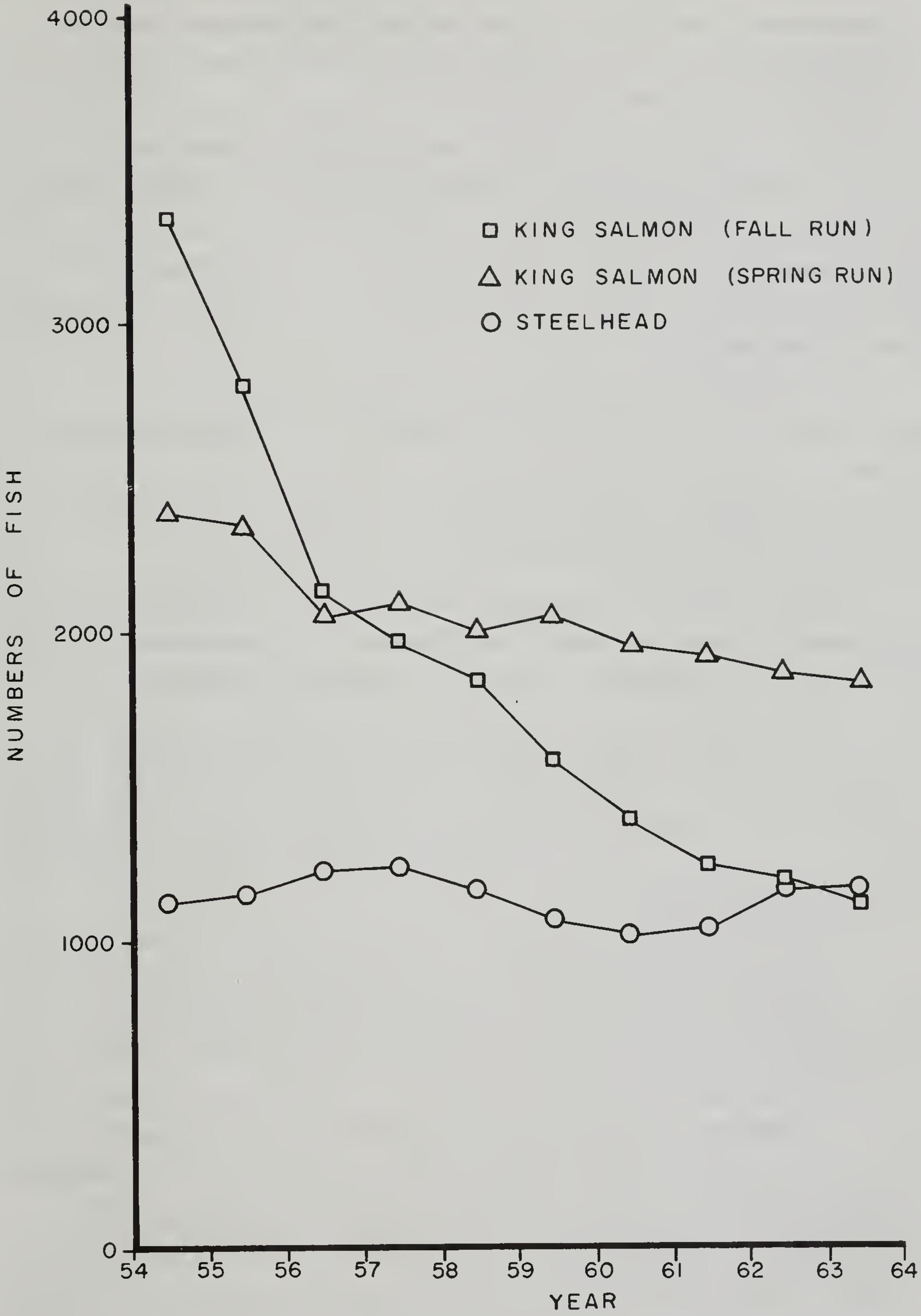

FIGURE 5

SALMON AND STEELHEAD POPULATION TRENDS
IN MILL CREEK 1954-1964

steelhead landed. Data collected in 1955 and 1957 indicated that the average success for spring-run salmon was 0.2 fish per angler-day or five days of fishing per fish.[2]

The resident fishes in Mill Creek include an abundance of trout in the canyon area and a mixture of both game and nongame warmwater species in the valley portion. The warmwater species receive only a very small amount of use. On the other hand, the rainbow and brown trout provide a good fishery in the upper part of the creek, even though access is limited.

The wild trout populations are supplemented with about 10,000 catchable-sized rainbow trout annually by the Department of Fish and Game. The catchables are planted in the vicinity of the "Hole in the Ground" and Mill Creek campgrounds, and the Highway 36 crossing to help support the heavy angling pressure at these points.

The fish in Mill Creek are confronted with several problems. Studies on Mill Creek by Gangmark and Bakkala (1960), indicated poor survival of fall-run salmon to swim-up, especially during years when large, scouring flows occur during the incubation period. The same is probably true but to a widely varying degree in other tributaries where flooding is common. Average mortality to fry stage was estimated to be about 96 percent; however, that figure may be somewhat high. Incubating spring-run salmon and steelhead eggs are probably also affected, but to a much lesser degree.

A partial barrier confronts spring-run salmon at Black Rock falls; thus, about ten miles of salmon holding and spawning area is under-utilized. Upstream steelhead migrations are probably blocked to a lesser extent.

Anadromous fish are forced to negotiate three dams prior to reaching the canyon. In the process, a few adult fish batter themselves to such an extent that they do not survive until they spawn. Spring-run salmon are particularly susceptible to fatal secondary infection resulting from injuries.

2/ Mill Creek was closed to salmon fishing in 1958

Some juveniles are undoubtedly lost in irrigation diversions, particularly at the Los Molinos Mutual Diversion Dam. Concentrations of stranded downstream migrants which had to be rescued in Dye Creek, an intermittent stream, strongly suggest the fish entered Dye Creek from the Los Molinos Mutual Ditch. The screen at the upper dam must be removed during high water periods to prevent its destruction.

Siltation may be a problem for spring-spawning steelhead trout and resident rainbow trout. The spring runoff in Mill Creek is characterized by high turbidity and is coincident with egg incubation for those species. Whether or not there is sufficient siltation to produce serious incubation mortality is unknown.

<u>Deer Creek</u>

Deer Creek supports anadromous populations of fall-run salmon, spring-run salmon, and steelhead trout. A few winter-run salmon also spawn there with little or no success. Spring-run salmon and steelhead migrate as far upstream as the upper falls. Fall-run salmon generally remain in the valley and seldom migrate above the mouth of the canyon.

Estimates of the number of fall-run salmon spawning in Deer Creek have been made each year except one since 1956. The spawning estimates have ranged from 2,200 fish in 1957 to ten fish in 1959, with an eight-year average of about 1,000 fish.

Unfortunately, fewer estimates of the numbers of spring-run salmon and steelhead are available. A counting station was constructed on the south fishway at Stanford-Vina Dam (Figure 6) as part of this study. The station was opened on March 20, 1963, and operated until June 12, 1963. A total of 1,702 spring-run salmon was counted. That probably constituted the bulk of the 1963 spring-run salmon migration. A small portion of the 1962-63 steelhead run was also enumerated (53 fish).

The counting station was reopened on October 13, 1963, and continued in operation until May 29, 1964. During that period, essentially all salmonids passing Stanford-Vina Dam were counted. The 1963-64 counts included 50 fall-run salmon, 2,878 spring-run salmon, and 1,006 steelhead.

Figure 6. Department of Water Resources Fish Counting Station on the Fishway at Stanford-Vina Dam

The U. S. Fish and Wildlife Service counted fish at a weir about one mile above Stanford-Vina Dam in 1941, 1942, and 1943 (Needham, op. cit.). Only partial counts were made because the racks had to be removed during high water. In 1941, 635 salmon were counted between May 20 and July 6. The following year, 1,108 salmon were counted from May 13 to July 3. In 1943, 812 salmon were enumerated between February 20 and June 16; however, the racks were inoperative much of that time. The 1942 counts included 145 steelhead, while in 1943, 109 steelhead passed the weir.

The resident game fishes in Deer Creek are dominated by rainbow and brown trout above the mouth of the canyon. A few warmwater species, including a largemouth bass, green sunfish, tule perch, and bullheads, occupy the valley part of the stream. A few smallmouth bass may be present. Nongame species include squawfish, suckers, and carp. A spring spawning migration of suckers and squawfish occurs in Deer Creek.

Trout angling pressure is heavy near access points, particularly where Highway 32 parallels upper Deer Creek, and in the major headwater tributaries. To help support this pressure, the Department of Fish and Game plants 40,000 catchable-sized rainbow trout annually in upper Deer Creek. Additional plants of 500 fish are made each year in Lost Creek.

Angling pressure is light between where the creek leaves Highway 32 and the mouth of the canyon, except in the vicinity of the Ponderosa Way crossing. Observations made during stream surveys in remote reaches of the creek indicated that a large majority of the fish present were probably juvenile steelhead. Fish under eight inches were abundant, while fish larger than that were scarce.

Perhaps the greatest obstacle encountered by salmon and steelhead migrating up Deer Creek is Stanford-Vina Dam. For years, the dam has caused severe mortality to spring-run salmon. Fall-run salmon have been rather effectively blocked in spite of fishways. The magnitude of steelhead losses is unknown; however, some mortality does occur. In 1946, 473 spring-run salmon carcasses were counted below the fish-counting racks and the dam. The following year, 108 salmon were lost. In 1963, approximately 320 salmon died below Stanford-Vina Dam and in 1964, 403 carcasses were counted, even though about 195 fish were rescued by the Department of Fish and Game. Estimates of delayed mortality caused by fish injuring themselves on the dam and dying from infection further upstream, are not available. Several fish counted over the dam exhibited injuries accompanied by severe fungus infections. Additional salmon losses can be attributed to the Deer Creek Irrigation District Dam at the mouth of the canyon.

Some downstream migrants may be lost in irrigation diversions before screens are installed in the spring. The screens are removed once all the water is diverted and reinstalled the following spring after the danger from high flows is past. It would be desirable to have the screens operate constantly or at least at all times when water is being diverted.

Fall-run salmon are adversely affected by high flood flows and scouring caused by unstable channels in the valley. Those problems are frequently compounded by levee maintenance operations during the incubation period. Spring-run salmon are usually faced with low flows and high water temperatures below Stanford-Vina Dam in June. High temperatures over a period of several days seems to reduce or eliminate their urge to migrate.

Spring-run salmon and steelhead sometimes find it impossible to ascend the lower falls on Deer Creek because of fishway failures. The ladder has suffered considerable damage and become impassable at least twice since 1962. When the upstream migration is interrupted by such a barrier, they concentrate below it and are vulnerable to poaching.

Big Chico Creek

The anadromous fishes entering Big Chico Creek include spring and fall-run king salmon and steelhead. Of these, spring-run king salmon are the most numerous. In 1958, a spawning escapement of 1,000 spring-run king salmon was estimated in Chico Creek. The run probably averages about 300 fish annually.

The majority of the fall-run salmon spawn below Bidwell Park. Spring-run salmon and steelhead migrate as far upstream as Bear Lake.

Very few estimates of fall-run king salmon spawning escapement have been made on Big Chico Creek. Fall flows are usually too low to induce large numbers of salmon to enter.

Essentially, no information is available regarding the magnitude of steelhead migrations into Big Chico Creek, although some are known to be present. The creek is not open to fishing during the regular steelhead season.

The fishery in the upper reaches of Big Chico Creek above Bidwell Park is supported by native rainbow and brown trout. The angling use per mile of stream in that area is light, although use near access points may be relatively heavy.

Anadromous fishes entering Big Chico Creek encounter several problems. Fall-run king salmon are generally confronted with low flows which provide little suitable spawning area. During low flow periods, the fish are vulnerable to poachers and other predators. Even though spring-run king salmon encounter more favorable flows during their upstream migration, they are faced with limited holding pools, low summer flows, and relatively high temperatures. Fish passage has been provided at the Corps of Engineers project and through Iron Canyon, a natural barrier in upper Bidwell Park. The overflow and bypass channels around Chico may provide places for adult and juvenile salmon and steelhead to become stranded.

Butte Creek

The spring king salmon run in Butte Creek is probably the second largest in the Central Valley area, exceeded only by that in the main stem Sacramento River. Spawning population estimates from 1956 through 1963 range from 500 fish to 6,800 fish, with an average of nearly 3,000. These figures do not include unknown numbers of fish which migrated upstream into a subsequently dewatered section above Centerville Powerhouse and were either caught by anglers or perished because of low flows and high temperatures. In spite of that loss, the 1963 spawning escapement, based upon a mark recapture program, was 4,600 fish. In 1964, a fish barrier was installed at Centerville (Figure 7) to prohibit salmon from migrating further upstream.

A few steelhead are known to utilize Butte Creek for spawning. The run probably doesn't exceed 100 fish.

Figure 7. Centerville Fish Barrier on Butte Creek

Fall-run king salmon normally are denied access to Butte Creek by low fall flows and diversions in the Butte Sink area. There are some unverified reports of fall-run king salmon spawning in Butte Creek during years when large fall flows are present. Normally, there is not enough water for fish to get through the Butte Sink. Quite often fish become lost in the maze of ditches, canals, and drains. Fall-run salmon have been observed in ditches on the Gray Lodge Waterfowl Management Area.

Butte Creek, from its headwaters to the P. G. & E. diversion dam near the mouth of Inskip Creek, is an excellent trout stream. Brown and rainbow trout are particularly abundant in areas which are not readily accessible. The Department plants approximately 20,000 catchable-sized rainbow trout annually in the area between Butte Meadows and Jonesville -- the area of most intensive use. Another 13,000 catchable-sized trout are planted in DeSabla Forebay each year. The forebay receives water from the P. G. & E. Inskip diversion on Butte Creek in addition to water from the West Branch, Feather River.

Lower Butte Creek contains sizable populations of warmwater gamefish, primarily largemouth bass and catfish. Angling use is generally limited to local sportsmen because much of the area is posted against trespass.

Upstream migrant spring-run salmon are faced with a multitude of hazards. Among these are seven or eight diversion dams located in the valley floor. The fish must reach the holding area above Parrott-Phelan Dam before all the water is diverted from the creek. Fish entering Butte Creek must either come through a culvert at the mouth of the creek or through the Sutter Bypass. Upstream migrations of spring-run king salmon in Butte Creek begin slightly earlier than in either Mill or Deer Creeks.

Downstream migrants also face numerous obstacles. The young fish must reach the Sacramento River during periods of high flows to avoid being lost in the network of ditches and unscreened irrigation diversions. Spring-run salmon have adapted to conditions in Butte Creek more successfully than steelhead, as shown by differences in population sizes.

Other Tributaries

Inks, Paynes, Salt, and Little Antelope Creeks are intermittent during the summer and occasionally during the fall; consequently, their contributions to anadromous fisheries are small or negligible. Some adult salmon spawn in these streams during years with sustained high fall flows, but their progeny often do not leave the stream before it becomes intermittent. A few steelhead utilize Paynes Creek and resident trout are also found in its upper reaches.

Wildlife Populations

Within the geographical limits of this investigation, many species of wildlife exist. These form an important renewable natural resource of considerable economic importance.

Wildlife Habitat

Wildlife occurs directly in relation to the type, condition, and amount of habitat available. Habitat is controlled by soil types, climate, latitude, and altitude. Many habitat types are encountered ranging from subalpine regions in the upper reaches of the area through yellow pine forest, chaparral, foothill-woodland grass, agricultural lands, and marsh lands in lower reaches. The usefulness of these lands for wildlife is influenced by the availability of water and the effects of human modification such as agriculture and logging. Wildlife is restricted to suitable habitat.

Big Game

Blacktailed deer are the most important and abundant big game species in the area (Figure 8). A few resident deer occur along valley stream bottoms where cover is adequate and in parts of the lower foothills; however, a large majority of the deer in the area are migratory. The deer summer range extends from the foothills to the summit of the watersheds and into Lassen and Plumas Counties outside of the investigation area. Deer have been found to migrate from the vicinity of Eagle Lake and beyond Mountain Meadows Reservoir to the winter range just east of Red Bluff (Plate 1). With the first heavy fall storms they

migrate down into the foothills and spend the winter below snowline. Generally, they follow the ascending snowline back into the high country in the spring.

The winter range extends from the edge of the valley to the start of the Transition Life Zone at approximately the 4,000 foot level. The winter range consists of open woodland-grass in the lower areas with blue oak and wedgeleaf ceanothus the predominant woody species. With an increase in elevation, shrubs and trees increase in abundance and variety until the yellow pine forest is reached. Various combinations and interspersions of cover are found throughout the range.

Intensity of deer use of this area depends on weather conditions and herd numbers. During years of high deer numbers and snows extending into lower elevations, numerous deer are forced from an extensive summer range and concentrate on limited portions of the winter range. During such periods, excessive range use occurs and contributes to decline of the carrying capacity of the range. Under these conditions, heavy deer mortality commonly occurs. In more moderate years, use of the winter range area is established in years when the deer herd faces serious losses without its support and in years of heavy mass production. The winter range is considered the key to the size and welfare of the deer herd.

The investigation area supports deer taken in eastern Tehama, and portions of Butte, Lassen, and Plumas Counties. The deer kill in these counties, indicated in Table 3, accounts for 12 to 14 percent of the statewide deer kill. An estimated one-third of these, about five percent of the statewide deer kill, are partially dependent on the investigation area. The deer harvest is limited to bucks only in most years and considerable variations in total kill occur due to natural population adjustments, weather during the hunting season, and the availability of deer to the hunter.

Deer depredations occur in orchard and pasture areas of this portion of Tehama and Butte Counties. Deer taken on depredation permits in these counties during 1963, 1964, and 1965 were 71, 47, and 61 respectively.

TABLE 3

Buck Deer Kill Figures,
Butte, Tehama, Lassen, and Plumas Counties

Date	Butte	Tehama	Lassen	Plumas	Four-County Total	Statewide
1958-62 Average	1,402	3,051	3,125	2,021	9,589	66,352
1962	1,394	2,339	1,319	1,680	6,932	54,909
1963	1,145	2,651	1,023	1,797	6,616	56,814
1964	1,201	2,691	2,262	2,869	9,029	66,584
1965	1,151	3,100	2,415	2,457	9,123	61,224

Bears exist in the investigation area primarily at elevations above 4,000 feet. While they are infrequently seen, they have a high aesthetic value, especially in Lassen National Park where they are viewed by many park visitors. They are presently taken during the bear season by deer hunters as well as by hunters exclusively after bear. Between 1962 and 1965 the average bear kills reported for Butte and Tehama counties ranged from 38 to 27 bears. One bear was taken in Tehama County during 1964 because of building damage.

A few mountain lions reside within the general area inhabited by deer. They are seldom seen and cause very little harm. Because of their purported reputation with stockmen and other interests, bounties were offered in California until 1964. In spite of the bounty, the total kill between 1959 and 1963 in Butte County was only three lions. The reported kill for the same period in Tehama County was six lions.

Wild pigs are found within the area between Mill Creek and Antelope Creek. The pigs are from domestic stock that have become feral. They live in the lower foothill areas but occasionally wander into the valley. Pig hunting in the area is increasing in popularity, however, the animals occur mostly on private land and are not available to the general public.

Small Game

Several small game species occur in the area. Sierra grouse, mountain quail, snowshoe rabbits, and Douglas squirrels are found in the higher, mountainous areas. Bandtailed pigeons nest in timber areas and frequent the lower foothills in the winter. Grey squirrels live in the conifer-hardwood habitat and along valley water courses, particularly along the Sacramento River. Valley quail, mourning doves, Audubon cottontails, brush rabbits, and blacktailed jackrabbits are found at lower elevations. As agricultural and valley lands begin, valley quail, doves, and rabbits continue and pheasants are added to the list. Some of the highest densities of pheasants in the State are found in the rice growing areas of the valley.

Open hunting seasons are provided for all of these species, although some of the area is of limited importance for small game hunting. Three Butte Basin counties, however, are among the top ten counties in annual pheasant kill. Of the 724,600 pheasants reportedly taken statewide during the regular hunting season in 1962, Butte, Colusa, and Sutter counties produced 24 percent of the total. Over 18,000 acres within the Butte Basin were in licensed game bird clubs in 1964. These clubs enjoy an extended pheasant season under special regulations. During the 1964-65 licensed pheasant club season, over 6,000 hunter days were expended on these areas in addition to the regular season. There has been a steady growth in this type of hunting area in recent years and the trend is expected to continue upward.

While some small game species do not appear to be especially important, judging from annual kill estimates they support considerable local hunting. With increasing hunting pressure, their contribution will continue to grow.

Waterfowl

Some of the most valuable waterfowl habitat in the nation occurs within the study area. The Pacific Flyway supports a winter waterfowl population of ducks and geese numbering up to 15 million (Figure 9). Wintering habitat for waterfowl has been constantly shrinking for many years. The remaining lands are of paramount importance in maintaining the waterfowl population in this flyway. The Butte Basin supports a million or more waterfowl for several months each year and smaller numbers during the rest of the year. Well over two million birds per day occupy the basin for significant periods of time. A minimum population of 13,000 waterfowl are supported by the Butte Basin throughout the year and approximately 9,000 young birds are reproduced there. Waterfowl species using the area include ducks, geese, swans, and coots.

Figure 9. A Waterfowl Concentration in the Butte Basin

Some of the best private duck clubs in the State are located in the Butte Basin. Annual membership fees in some of the more exclusive clubs range in the thousands of dollars. The State Department of Fish and Game owns and operates the Gray Lodge Waterfowl Management Area in the lower basin. In addition to areas where waterfowl habitat is natural or where lands are managed for waterfowl, the birds depend on adjoining agricultural lands that are flooded by high flows. These occasionally flooded lands have high values for waterfowl and their loss would be detrimental to the entire Pacific Flyway.

Two areas of special waterfowl interest are indicated on Plate 1. The lower Butte Basin lying east of Colusa is one of the most heavily used waterfowl areas in the State. The Los Molinos-Vina plains support large numbers of wintering geese after new grass sprouts following fall rains. With the ponding of water on the plains, ducks also utilize the area.

Other Wildlife

Several species of nongame animals inhabit the area. Furbearers are common and are found throughout both the mountain and valley areas. They are of value aesthetically as well as commercially. Table 4 indicates the species of animals taken by trappers in 1963-64 by county. It should be noted that these figures more nearly reflect the demands of the fur market instead of actual population sizes. Among these animals, beavers have a special aesthetic value. Other animals are sometimes considered to be predators because of occasional conflict with human interests.

TABLE 4

Fur Animal Take by County, 1963-64

Species	Butte County	Tehama County	Glenn County	Colusa County	Sutter County
Beaver	105	39	33	6	10
Bobcat	5	0	26	0	0
Coyote	8	0	11	0	0
Fox	6	0	11	4	3
Mink	0	0	0	1	0
Muskrat	7,864	59	4,530	10,450	4,992
Oppossum	22	13	10	0	0
Raccoon	92	61	59	17	9
Ring-tailed cat	8	5	8	0	0
Striped skunk	89	10	22	0	1
Spotted skunk	4	0	6	0	0
Potential fur value 1/	$10,064	$462	$5,650	$10,740	$5,624

1/ Based on average fur prices received for furs from the above animals.

Several problems are associated with furbearers. Rabies are occasionally carried by these animals and control measures must be taken. Muskrats and beaver burrow into and weaken levees. Beavers create water diversion difficulties and sometimes flood out areas that allegedly have a greater value for other uses. Control measures are sometimes required but usually these animals exist quietly in their respective areas, dependent on special habitat requirements.

The entire investigation area supports a diverse and numerous songbird population. The various species are not listed because of the numbers involved. Almost all the songbirds are totally protected. They have high aesthetic values and serve useful purposes in the biotic community.

CHAPTER 4. THE MILL-DEER PROJECT

Descriptions of Possible Developments

Three possible developments were studied on Mill and Deer Creeks. These were the Initial Mill-Deer Project, the Sugarloaf Power Development, and Savercool Reservoir. The Department of Water Resources determined that only the Initial Mill-Deer Project appeared to be economically justified. All of the possible developments are illustrated on Plate 2.

Initial Mill-Deer Project

The Mill-Deer Project consisted of several features, including Morgan Springs Diversion, Childs Meadows Conduit, Deer Creek Meadows Reservoir, Ishi Diversion Dam, Yahi Canal, Crown Reservoir, and Vina Canal. All of these would be integrated into a multiple purpose complex designed to provide water conservation, flood control, recreation, and fisheries benefits.

Morgan Springs Diversion Dam, a 15-foot high structure, would be constructed on the upper reach of Mill Creek in Section 23, T29N, R4E at a normal pool elevation of 4,915 feet. The dam would divert surplus water from Mill Creek via the Childs Meadow Conduit into Deer Creek Meadows Reservoir for storage. Water would be diverted during excess flow periods between December 1 and June 30.

The Childs Meadow Conduit would extend almost six miles from Morgan Springs Diversion Dam to Deer Creek Meadows Reservoir. The conduit would have a maximum capacity of 250 cfs and an average gradient of about 38 feet per mile. To preserve the aesthetic and recreational values of the meadow area and to provide for safe passage of migrating deer herds, the conduit would be constructed of buried steel pipe.

Deer Creek Meadows Reservoir would be formed by a 193-foot earthfill dam in Section 21, T28N, R5E. The reservoir would have a capacity of 153,000 acre-feet and a surface area of 2,000 acres at the normal pool elevation of 4,700 feet. Dead pool would include 43,000 acre-feet and cover 1,100 acres. Dead pool elevation would be 4,630 feet. Maximum possible drawdown would be 70 feet.

Ishi Diversion Dam would be located on the lower reach of Deer Creek in Section 23, T25N, R1W. The concrete dam would be about 30 feet high and would divert water through Yahi Canal into Crown Reservoir.

Yahi Canal would be an unlined canal approximately two and one-half miles long with a maximum capacity of 200 cfs. The canal would serve as a water conveyance and as an artificial spawning channel for fall-run king salmon.

Crown Reservoir would be formed by a 50-foot dike-type dam in Sections 10, 14, and 15, T24N, R1W on Brush Creek. Normal pool would include 11,000 acre-feet at an elevation of 304 feet. The large, shallow reservoir would inundate 730 acres. Dead pool would inculde 1,000 acre-feet at elevation 282 feet and would cover 140 acres. Maximum vertical drawdown would be 22 feet. A 190 cfs capacity, concrete lined canal, the Vina Conduit, would link Crown Reservoir and the existing Stanford-Vina Dam on Deer Creek to tie into local irrigation systems at that point.

<u>Sugarloaf Power Development</u>

This development was studied as a hydroelectric power adjunct to the Mill-Deer Project. The main feature consisted of a possible Sugarloaf Dam and Reservoir on the upper reach of Deer Creek. This 30,400 acre-foot reservoir would be impounded by a 270-foot dam in Section 33, T27N, R3E. The reservoir would inundate 310 acres at an elevation of 2,860 feet. Various canals, forebays, afterbays, and powerhouses would be included as off-stream developments (Plate 2). Reduction in power revenues, high capital costs, and major fishery problems were the principle factors which determined project infeasibility.

<u>Savercool Reservoir</u>

The possiblity of constructing a small dam and reservoir on Mill Creek near Black Rock for recreation, water conservation, and reservoir fishery purposes was studied. A 170-foot dam in Section 13, T27N, R2E would impound 6,750 acre-feet. Because of the low predicted recreation use, the small amount of water yield, and the downstream fishery problems, this project was not considered to be economically justified.

Probable Effects of Projects Upon Fish

The Mill-Deer Projects would have both beneficial and detrimental effects upon fish and wildlife resources. The Initial Mill-Deer Project would be beneficial to fish, but the Sugarloaf Power Development and Savercool Projects would be detrimental. Any reservoir would result in the loss of valuable wildlife habitat.

Initial Mill-Deer Project

The Morgan Springs Diversion Dam on Mill Creek may prove to be a barrier to upstream migrating steelhead and resident trout. That possibility was not investigated thoroughly and should receive further consideration prior to completion of feasibility studies. A fishery might be required over the diversion dam. Water diversion dam. Water diversion would necessitate a flow maintenance schedule for downstream fishery releases at the diversion site.

The diversion dam should be a demountable structure and removed when water is not being diverted. That would insure minimum water temperature increase resulting from any pool behind the dam.

Fish passage difficulties at Black Rock falls on Mill Creek should be eliminated to partially compensate for reductions in Mill Creek flows during the winter and spring months. Only a relatively minor amount of blasting might be required to substantially improve fish passage at that point.

Childs Meadow Conduit would result in serious erosion and siltation problems if connected to the upper end of Gurnsey Creek. Trout spawning habitat in the creek would be degraded or lost entirely. Redds of spring-spawning rainbow trout could be stranded after diversions cease. Spawning trout from the reservoir would be attracted into a canal or closed conduit with no hope of successful spawning unless access is blocked. On the other hand, the additional water could provide good attraction for spawners searching for a tributary in which to spawn. Location of the buried conduit outlet at the mouth of Gurnsey Creek would help attract trout that are ready to spawn in Gurnsey Creek.

Low fall flows in Gurnsey Creek might be boosted by about five cfs between October 1 and June 30 by providing a turnout from the Childs Meadow Conduit. The five cfs would result in a very slight change in Mill Creek, but might produce significant benefits in Gurnsey Creek. This possibility should be explored further at feasibility level.

Deer Creek Meadows Reservoir would have great potential for enhancing fish habitat both within the reservoir and downstream. The loss of six miles of trout stream would be replaced by a good reservoir fishery for brown and rainbow trout. An occasional brook trout could be expected in the catch. Inundation of spawning gravels for trout could be compensated by channel improvements and slight increases in the fall flow of Gurnsey Creek.

The reservoir could be expected to be fairly productive. Natural reproduction conditions would be excellent in Gurnsey Creek, particularly with improved fall flows. Although no fish are known to exist in the drainage which would become a problem in the reservoir, that possibility should be explored more fully during feasibility studies. Wilson Lake should be rigorously sampled to determine what fish reside there. The potential reservoir yield was estimated at about 20 pounds of trout annually per surface-acre. If we assume that the surface area would average about 1,700 acres during the summer, the gross annual yield would be approximately 34,000 pounds. At four fish per pound, this represents about 136,000 fish. With such a yield, the reservoir would be capable of supporting about 68,000 angler-days annually. A detailed management plan should be formulated for the reservoir prior to completion of feasibility studies.

Preliminary temperature predictions were made for Deer Creek Meadows Reservoir by using Bucks Lake (Plumas County) as an analogy.

The reservoir would be similar to Bucks Lake in several respects. They are approximately 30 air-line miles apart. Vertical temperature measurements were made monthly at Bucks Lake from July through October 1964. Analysis of these data led to the following conclusions: 1) that Deer Creek Meadows Reservoir would stratify thermally, 2) that the surface water temperature would approach 70° for a short time, 3) that the average summer thickness of the epilimnion would be about 25 to 30 feet, and 4) that a properly designed multi-level outlet structure would be capable of withdrawing water at any temperature from 50° to 65° throughout the summer and early fall. Predicted isotherms for Deer Creek Meadows Reservoir are shown in Figure 10.

Operation studies reveal that the project would essentially double the summer flows at Polk Springs -- the heart of the spring-run salmon holding and spawning area (Table 5). The increased flows and reduced water temperatures at the damsite, coupled with the large amount of accretion from tributaries and springs below the dam, would greatly enhance Deer Creek for spring-run salmon, steelhead, and resident brown and rainbow trout.

Water temperature profile studies on Deer Creek along with stream surveys and published data (Needham, op. cit.) indicated that the present downstream limit of temperatures suitable for holding spring-run salmon is near the mouth of Rock Creek. Daily maximum water temperatures at that point are seldom greater than 70° under present conditions. Under project conditions, the temperatures at that point would be reduced and the salmon holding area might be extended downstream by approximately ten miles to the vicinity of Ishi Diversion Dam.

The larger flows would increase the amount of spawning and rearing areas for spring-run salmon and steelhead as well as increase the holding area for adult salmon. Increased water depth would render usable many peripheral gravel bars that are presently unsuitable for spawning because of shallow water.

Needham (op. cit.) estimated that Deer Creek had a spring-run salmon spawning capacity of about 12,000 fish below the Upper Deer Creek

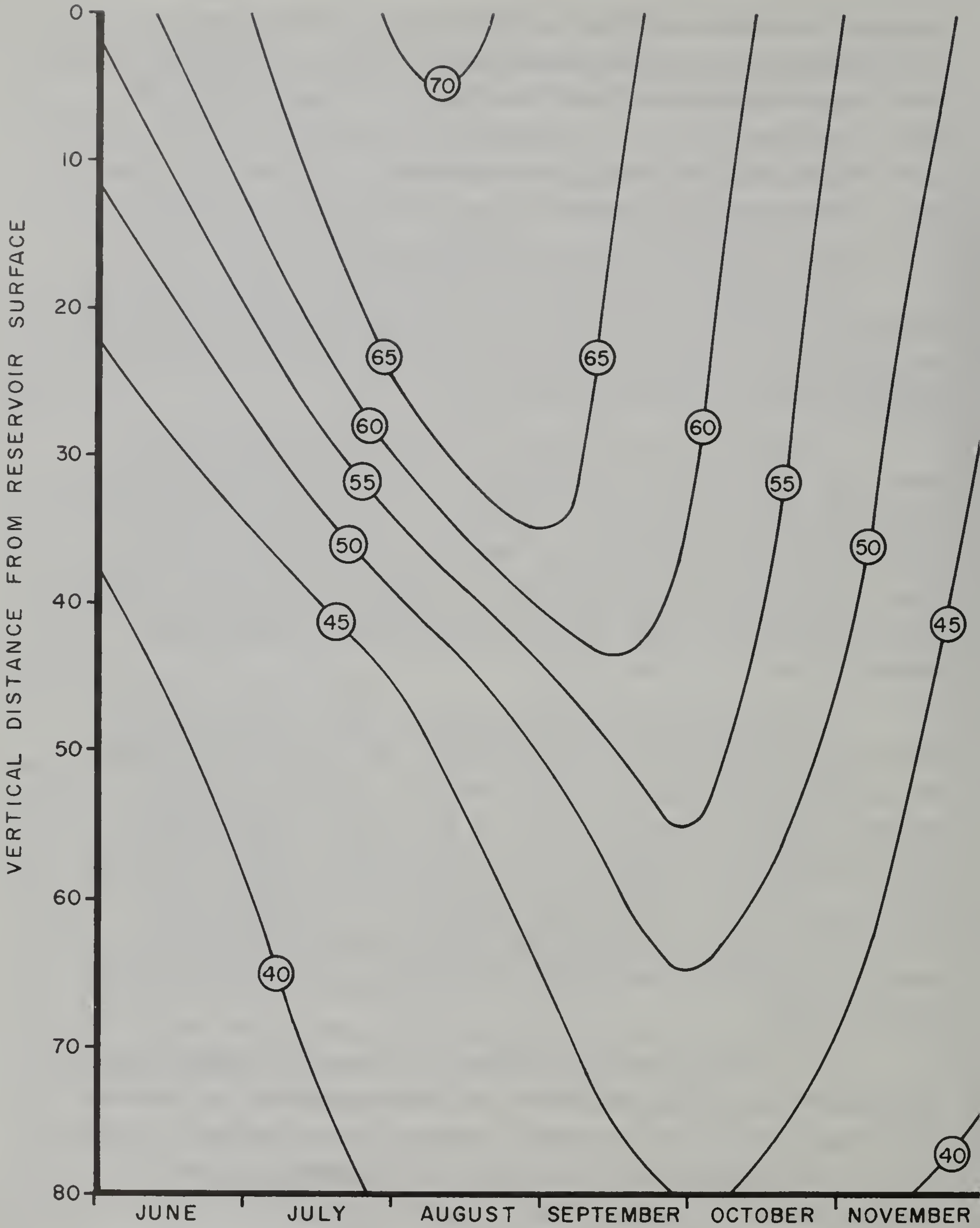

FIGURE 10

PREDICTED ISOTHERMS FOR DEER CREEK MEADOWS RESERVOIR
(EFFECT OF OPERATION NOT ILLUSTRATED)

TABLE 5

Flows With and Without Deer Creek Meadows Reservoir to Indicate Flow Changes (in 1,000 acre-feet)

	Oct.	Nov	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.
Dry Year - 1932-33												
Deer Cr. Meadows: Pre-project	1.4	1.4	1.7	2.0	1.3	5.2	4.6	4.5	2.8	1.5	1.3	1.3
Deer Cr. Meadows: Post-project	8.6	10.4	9.2	3.8	2.6	1.5	1.5	1.5	3.0	4.6	6.1	5.9
Flow at Polk Spr.: Post-project	11.0	12.4	12.4	7.7	6.5	6.9	10.6	10.2	7.9	7.2	8.4	8.1
Flow at Vina: Post-project	11.4	13.5	13.4	9.7	8.9	16.0	12.7	12.1	8.2	7.6	8.8	9.5
Flow at Vina: Pre-project	4.2	4.3	5.8	7.9	7.6	19.7	15.8	15.1	8.0	4.5	4.0	3.9
Dry Year - 1933-34												
Deer Cr. Meadows: Pre-project	1.5	1.5	5.8	2.7	3.4	5.3	3.6	2.4	1.5	1.2	1.1	1.0
Deer Cr. Meadows: Post-project	8.6	5.2	4.6	3.8	2.6	1.5	1.5	3.1	3.0	4.6	6.1	5.9
Flow at Polk Spr.: Post-project	11.2	7.5	13.8	10.1	13.5	8.7	6.9	6.5	5.7	6.8	8.0	7.8
Flow at Vina: Post-project	11.6	8.1	19.3	18.1	18.1	12.0	8.0	7.0	6.1	7.2	8.4	8.2
Flow at Vina: Pre-project	4.5	4.4	20.5	17.0	18.9	15.8	10.1	6.3	4.6	3.8	3.4	3.3
Normal Year - 1935-36												
Deer Cr. Meadows: Pre-project	1.7	1.5	1.9	4.0	8.4	6.6	7.9	4.6	3.3	2.0	1.6	1.5
Deer Cr. Meadows: Post-project	8.6	10.4	9.2	7.7	5.3	3.1	3.0	3.1	3.0	4.6	6.1	5.9
Flow at Polk Spr.: Post-project	11.6	13.5	13.0	20.7	28.9	11.6	19.1	11.2	8.9	8.1	8.8	8.6
Flow at Vina: Post-project	11.9	13.9	13.8	40.9	49.2	18.9	23.1	13.0	9.1	8.4	9.2	9.0
Flow at Vina: Pre-project	5.0	5.0	6.5	37.2	52.3	22.4	28.0	14.5	9.4	5.8	4.7	4.6
Normal Year - 1945-46												
Deer Cr. Meadows: Pre-project	3.0	2.9	12.9	2.4	1.8	5.2	6.2	4.4	2.9	2.4	2.0	1.9
Deer Cr. Meadows: Post-project	8.6	10.4	9.2	7.7	5.3	3.1	3.0	3.1	3.0	4.6	6.1	5.9
Flow at Polk Spr.: Post-project	14.0	16.4	35.3	15.7	11.9	10.0	18.8	13.9	8.3	8.8	9.7	9.2
Flow at Vina: Post-project	14.2	20.7	57.4	30.0	16.9	19.0	22.1	16.3	8.5	9.1	10.0	9.5
Flow at Vina: Pre-project	8.6	13.2	61.1	24.7	13.4	21.1	25.3	17.6	8.4	6.9	5.9	5.5
Wet Year - 1937-38												
Deer Cr. Meadows: Pre-project	2.0	4.6	14.4	1.9	9.0	19.7	11.7	14.1	10.8	4.2	3.0	2.6
Deer Cr. Meadows: Post-project	8.6	10.4	9.2	7.7	5.3	3.1	8.6	13.5	9.8	4.6	6.1	5.9
Flow at Polk Spr.: Post-project	11.8	23.1	47.8	15.9	37.3	34.4	42.9	54.4	34.0	10.2	11.0	10.0
Flow at Vina: Post-project	12.4	31.2	75.8	27.8	74.3	81.4	54.9	69.4	43.0	12.2	11.7	10.7
Flow at Vina: Pre-project	5.8	25.4	81.0	22.0	78.0	98.0	58.0	70.0	44.0	11.8	8.6	7.4
Wet Year - 1955-56												
Deer Cr. Meadows: Pre-project	1.8	1.7	24.5	6.7	8.0	8.3	8.7	11.2	6.1	3.8	2.7	2.5
Deer Cr. Meadows: Post-project	8.6	10.4	9.2	7.7	5.3	8.3	8.7	10.6	5.1	4.6	6.1	5.9
Flow at Polk Spr.: Post-project	11.8	14.4	64.7	38.0	30.3	19.8	30.0	38.4	16.7	10.3	10.8	10.3
Flow at Vina: Post-project	12.1	15.8	96.9	97.7	53.5	32.7	34.8	44.1	19.2	11.4	11.1	10.6
Flow at Vina: Pre-project	5.3	7.1	112.2	96.7	56.2	32.7	34.8	44.7	20.2	10.6	7.7	7.2

falls. Observations made during this study lead to the conclusion that other factors such as poor fish passage, lack of permanent screening, disease prevalence, and limited holding areas are far greater contributors to population depression than lack of spawning area. In 1962 and 1963, an intensive stream survey revealed there are roughly 200 pools capable of holding spring-run salmon, with a total estimated holding capacity of about 8,000 fish. Doubling the summer flow and reducing stream temperatures would increase the holding capacity by perhaps as much as 50 percent. Post-project conditions should produce a net holding capacity increase of about 4,000 fish. Temperature reductions might also lower the disease induced mortality.

The steelhead rearing capacity of Deer Creek would be enhanced with larger summer flows and reduced temperatures. Production of fish-food organisms would be boosted with the increase in wetted perimeter during the summer. Introduction of mineral-rich, Mill Creek water into the Deer Creek drainage would also benefit the aquatic productivity of Deer Creek. All factors considered, it was estimated that the steelhead spawning run could be increased by about 50 percent or an average of roughly 500 adults annually.

The Ishi Diversion Dam would present an unsurmountable obstacle to upstream migrating spring-run salmon and steelhead unless satisfactory fish passage facilities are installed. The diversion dam should be built as low as practical and store as little water as possible to curtail water temperature increase due to water retention within the pool behind the dam. Consideration should be given to designing the dam so fish would be led into the fish ladder without delay. This could be accomplished by adding a large attraction flow to the first or second pool near the entrance of the ladder. Consideration should also be given to constructing the dam at a 30 to 45 degree angle to the streamflow to lead fish to the ladder.

Releases below Ishi Diversion would be necessary to maintain fall-run king salmon. Substantial fish passage improvements at Stanford-Vina Dam would enhance the anadromous fish populations in Deer Creek. Because fall-run salmon spawning areas above Stanford-Vina Dam are currently under-utilized, the fall run could be greatly increased by improving fish passage at that point even though only a maintenance flow would be released.

Spawning gravel field studies in conjunction with studies of large-scale aerial photographs (one inch equals 100 feet) indicated a spawning potential for about 3,200 fall-run salmon at maintenance flows below Ishi Diversion. Presently over 75 percent of the fall-run salmon spawn below Stanford-Vina Dam.

Direct losses of spring-run salmon at Stanford-Vina Dam in 1963 and 1964 included about 320 and 400 fish, respectively. Indirect losses, that is fish which are injured to the extent they do not survive to spawn in the fall, may be as great or greater. Carcass surveys between Stanford-Vina Dam and Highway 99E conducted during the 1964 spring migration indicated a preponderance (about 90 percent) of female salmon among those destroyed by the dam. Projection of that number of females with a standard sex ratio (one and one-half males per female) is equivalent to a run of nearly 1,000 adult salmon. The dam is undoubtedly one of the greatest factors preventing the run from reaching the potential carrying capacity of the creek.

Losses of adult steelhead attributable to Stanford-Vina Dam are much more subtle and difficult to assess; however, they are though to be considerably less than thos of spring-run salmon. Spent, down-stream migrant steelhead are reluctant to pass over the dam at low flows. This migration occurs from March through June, with 75 to 80 percent of the migrants passing in April and May (Needham, op. cit.) when low flows over the dam are common. Some fish refuse to pass, and are eventually lost.

Losses of fish at Stanford-Vina Dam must be eliminated to enhance anadromous fish in Deer Creek. The best means of accomplishing that objective would be to remove the dam and develop suitable substi-tute water diversion and conveyance facilities. If this proves to be infeasible, fish passage improvements should include leading devices to direct the fish to the ladders. Improvements should also include downstream channel control.

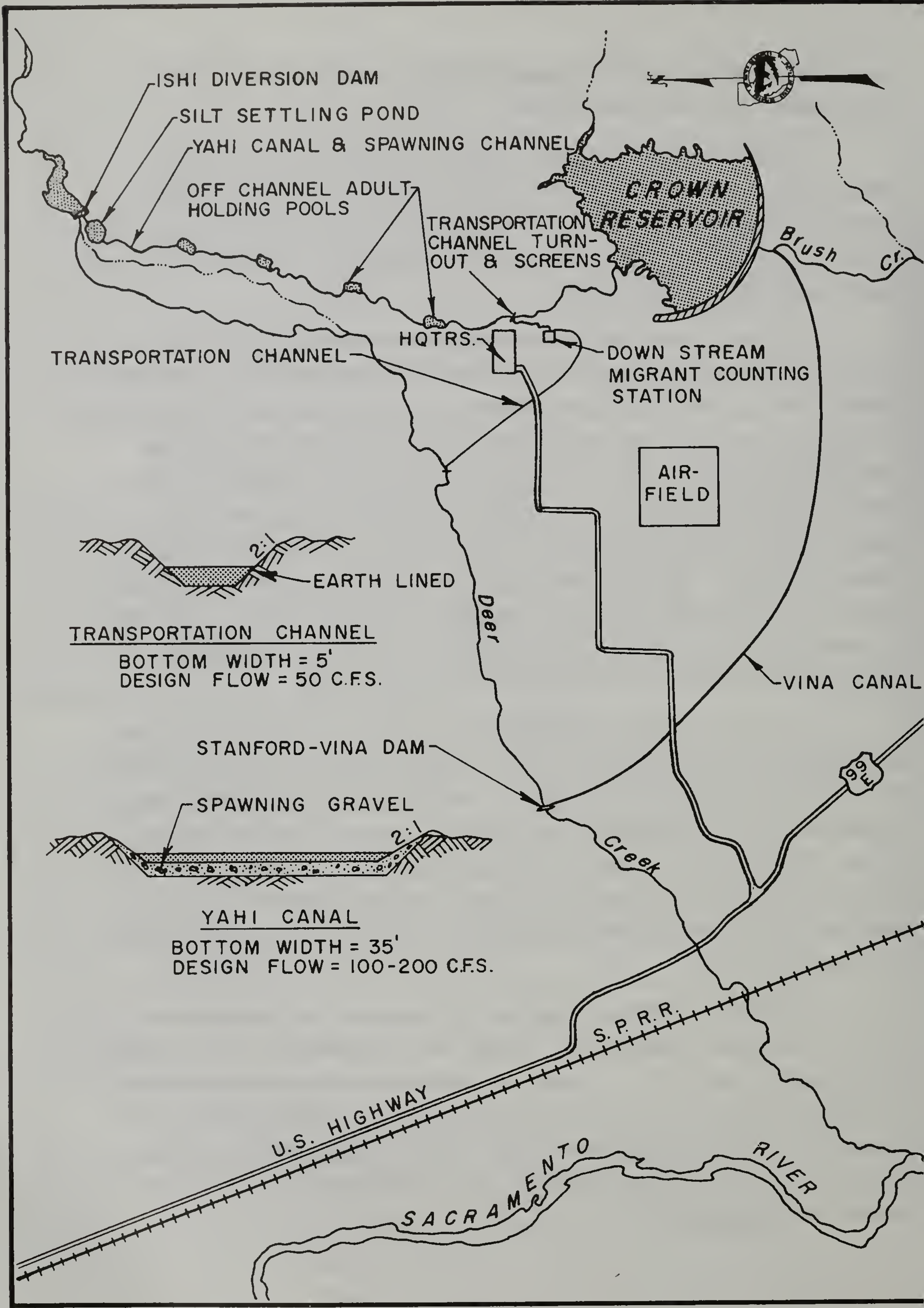

FIGURE 11

YAHI CANAL AND PROPOSED SPAWNING FACILITIES FOR FALL RUN KING SALMO
SCALE 1" = 1 MI.

Yahi Canal would serve as a water conveyance channel between Ishi Diversion Dam and Crown Reservoir. The canal would also function as an artificial spawning channel for fall-run king salmon (Figure 11). The channel would have a bottom width of 35 feet and would be about 13,700 feet long. With ten percent of the length devoted to resting pools, silt settling pools, invert controls, etc., the channel would provide 430,000 sq. ft. of graded-gravel spawning area at a design flow ranging from 100 to 200 cfs during the spawning season.

A fish control structure would be required on Deer Creek to direct adult salmon into the spawning channel through a transportation channel. Fall-run salmon would be separated from steelhead at that point. Steelhead would be returned to the creek to proceed upstream. The transportation channel would have a bottom width of five feet and carry a design flow of 50 cfs. If the transportation channel has velocities exceeding two fps over a length of 400 feet, resting areas will be required. Spawning channel flows in excess of 50 cfs would be delivered to Crown Reservoir.

Other features of the channel would include screening at both ends, a deer-crossing bridge, and a silt-settling basin. Off-stream holding pools for adults may be desirable so the pools can be isolated from the channel after spawning is over. Trees should be planted along the channels to provide shade and reduce water temperatures in early fall and late spring. The entire channel should be enclosed in a six-foot chain link fence to keep out livestock and predators and to discourage poaching. Electronic downstream migrant counting facilities should be included in the transportation channels to monitor the success of the spawning channel. Check structures with removable fish racks should be installed in the spawning channel at intervals not greater than 500 feet to control the distribution of spawners within the channel. A gravel service road should parallel the spawning channel.

A headquarters building, shop, garage, and storage building should be constructed. Two or three permanent dwellings should be built to house the operators of the channel. Manpower requirements would include a foreman, two full-time assistants, and 18-man-months of seasonal help.

The channel would have a maximum spawning capacity of 18,000 salmon (Table 6). The potential harvest of fish spawned in the channel would average approximately 60,750 fish annually, including 48,250 in the commercial catch, 8,800 in the ocean sport catch, and 3,700 in the river or inland sport catch.

Based upon estimated sightseeing visitors at some of the larger State trout hatcheries, the artificial spawning facility would be expected to attract an average of about 25,000 visitors annually during the initial decade of operation. Parking, rest rooms, a visitor's viewing area, and other facilities should be provided to adequately handle the expected use. Visitor-day use projections, based upon State population projected growth, from 1970 through 2020 are listed in Table 7.

TABLE 6

Yahi Spawning Channel Evaluation 1/

Spawning Area in sq. ft.	430,000 sq. ft.
Maximum females (60 sq. ft. per female)	7,200 females
Maximum spawners (1.5 males per female)	18,000 salmon
Average spawners (75 percent of maximum)	13,500 salmon
Predicted survival to downstream migration	about 60 percent
Potential catch to escapement ratio	about 4.5 to 1
Total adult production (including spawners)	74,250 salmon
Potential sport and commercial catch	60,750 salmon
Potential commercial catch	48,250 salmon
Potential sport catch	12,500 salmon
Ocean sport catch	8,800 salmon
River sport catch	3,700 salmon

1/ Many of the parameters involved in this evaluation are currently being reviewed; consequently, these figures should be considered preliminary pending the outcome of that review.

TABLE 7

Estimated Visitor Attendance, Yahi Spawning Channel

Decade	Estimated Average Annual Visitors
1970 - 1980	25,000
1980 - 1990	30,000
1990 - 2000	40,000
2000 - 2010	47,500
2010 - 2020	55,000

Crown Reservoir would support a warmwater fishery for largemouth bass, catfish, crappie, and bluegill. Average annual yield might reach ten pounds of fish per surface acre. Based upon an estimated average surface area during the growing season of 400 acres, the reservoir would yield about 4,000 pounds of fish annually. About one pound of warmwater fish is required to support an angler-day.

Deer Creek may be used as a source of materials for constructing Crown Dam. If that is the case, provisions should be included to preserve sufficient salmon spawning gravels.

Construction of a simple type of artificial fish shelter within Crown Reservoir should be considered to concentrate fish because of the broad expanse of shallow water. By concentrating fish and fishermen, the yield would undoubtedly increase.

Initial fish stocking costs would be about $3,650 or $5 per surface-acre. If benefits are claimed for the Crown Reservoir fishery, the project sponsor should assume these costs. A minimum pool reservation of 1,000 acre-feet would also be necessary to support fish during drawdown periods.

To protect the salmon spawning gravels in lower Deer Creek from removal or degradation, the project sponsor should acquire the Deer Creek streambed and riparian land between Ishi Diversion Dam and the Sacramento River. Acquisition could either be by easement or fee purchase. Although somewhat more expensive, acquisition by purchase would insure public access for fishing and other recreational use. If purchased, the strip might be designed to connect with the existing Woodson Bridge State Recreation Area, and, with their approval, be operated by the Department of Parks and Recreation. Actual recreational development along the stream should be held to minimum to retain the natural beauty of the area. Boundaries of the land suggested for acquisition have not been delineated; however, no lands presently under intensive agricultural or residential use should be included. By the same token, assurance should be given adjacent landowners that this acquisition will not interfere with existing water rights.

A ten-year post-project evaluation should be supported by the project sponsor. The studies should be conducted by a Fishery Biologist, who would be in charge of the entire fisheries operation during that period. He would be responsible for integrating all fishery functions of the entire project and formulate the final management plan. He would evaluate improvements in Gurnsey Creek, management of the reservoir fisheries in Deer Creek Meadows and Crown Reservoir, temperatures and fish passage in Deer Creek Canyon, fish passage at Ishi and Stanford-Vina Diversion Dams, and success of the Yahi Spawning Channel. Such a program would insure optimum returns on the investment in the fishery. The present-day cost of such a program would be approximately $50,000 per year. The evaluation of Yahi Spawning Channel should not be limited to counting returns to the channel, but should also include returns to the fisheries in the river and ocean. The study should be integrated with the program of the Pacific Marine Fisheries Commission.

Maintenance Requirements. The following recommendations are made to preserve fishery resources with construction of the Initial Mill-Deer Project:

1) Further consideration should be directed toward determining the need for fish passage facilities at Morgan Springs Diversion Dam on Mill Creek.

2) The Morgan Springs Diversion Dam should be a demountable structure and should be removed when water is not being diverted.

3) Fish passage difficulties at Black Rock falls should be eliminated by blasting or a combination of blasting and concrete work.

4) The following downstream fishery releases should be made in Mill Creek below the Morgan Springs Diversion Dam:

Dec. 1 - May 31:	35 cfs or natural flow, whichever is less.
June[2/] 1 - June 15:	150 cfs or natural flow, whichever is less.
June 16 - June 30:	150 cfs on June 16 graduated up to 200 cfs or natural flow by June 30.
July 1 - Nov. 30:	Full natural flow.

5) The Childs Meadow Conduit should be closed and screened at each end. The conduit should enter Deer Creek Meadows Reservoir in the immediate vicinity of Gurnsey Creek.

6) A minimum storage of 40,000 acre-feet should be retained in Deer Creek Meadows Reservoir to sustain trout populations during the drawdown period.

7) Further studies should be conducted to determine what non-game fishes are present in the drainage above Deer Creek Meadows Reservoir and whether they would present problems.

8) The design for Deer Creek Meadows Dam should include multiple outlets to permit selection of optimum water temperatures for downstream release.

9) Extreme care should be exercised during construction of Deer Creek Meadows Dam to avoid downstream silt pollution.

10) Satisfactory fish passage facilities should be provided at Ishi Diversion Dam. Provisions should also be made for leading fish to the facilities.

2/ The effects of diversions during the month of June should be investigated in more detail during feasibility studies.

11) The following releases should be provided below Ishi Diversion Dam:

Oct. 15 - Dec. 31:	125 cfs or natural flow, whichever is less.
Jan. 1 - Feb. 29:	100 cfs or natural flow, whichever is less.
Mar. 1 - June 15:	75 cfs or natural flow, whichever is less.
June 15 - Oct. 14:	Existing imparied flow or more.

12) Ishi Diversion Dam should be as low as possible and store as little water as possible to avoid undesirable water temperature increases.

13) The fall-run king slamon spawning gravels in Deer Creek between Ishi Diversion Dam and the Sacramento River should be acquired by purchase or easement.

14) The Yahi Canal should be screened to prohibit downstream migrant salmon and steelhead from entering Crown Reservoir.

15) Further study should be conducted to determine the effects of borrowing constuction materials from Deer Creek for Crown Dam.

Enhancement Opportunities. There are a number of ways to enhance the fish resources of Deer Creek. These are listed below:

1) A 25 cfs turnout and delivery of five cfs or more from the Childs Meadow Conduit to Gurnsey Creek might enhance the trout spawning potential in Gurnsey Creek.

2) Further study should be conducted to determine the feasibility of physically improving trout spawning riffles in Gurnsey Creek.

3) Trout production would be increase sufficiently with the construction of Deer Creek Meadows Reservoir to support a fishery amounting to 68,000 angler-days per year.

4) Spring-run salmon and steelhead trout habitat will be improved by increased summer flows and decreased water temperatures in Deer Creek below Deer Creek Meadows Reservoir. The following release schedule was established during the course of this investigation:

Month	Flow in cfs	Flow in acre-feet
October	140	8,600
November	175	10,400
December	150	9,200
January	125	7,700
February	95	5,300
March	50	3,100
April	50	3,000
May	50	3,100
June	50	3,000
July	75	4,600
August	100	6,100
September	100	5,900

5) Fall-run salmon production would be greatly magnified by the construction of an artificial spawning channel in Yahi Canal.

6) Elimination of fish passage problems at Stanford-Vina Dam would be essential to measurably increase the production of fall-run salmon, spring-run salmon, and steelhead trout in Deer Creek.

7) Provisions for permanently screening irrigation diversions from Deer Creek would enhance anadromous fish production in the creek.

8) A minimum pool of 1,000 acre-feet should be retained in Crown Reservoir to support fishlife in the reservoir.

9) The project sponsor should stock the reservoir initially with warmwater gamefish. The cost would be approximately $3,650.

10) Acquisition of a strip along lower Deer Creek and the assurance of public access would increase angler use and permit the resources to be more fully utilized once they are enhanced.

11) The project sponsor should support a ten-year post-project evaluation to insure maximum returns in fishery enhancement investments.

Sugarloaf Power Development

The Sugarloaf Power Development would be severely detrimental to spring-run salmon and steelhead in Deer Creek. In fact, much of the enhancement produced by the Initial Mill-Deer Project would be negated. Approximately ten miles of spring-run salmon and steelhead would be blocked, because it would not be practical to pass fish over the 270-foot dam. As a result, artificial holding and spawning faciltiies would be required to handle these fish. Although no detailed temperature studies were undertaken, Sugarloaf Reservoir could create downstream temperature problems in the summer and fall. At best, Sugarloaf Reservoir would produce only a poor trout fishery because of the relatively rapid rate of water interchange in the reservoir. Consequently, the Department of Fish and Game would oppose the Sugarloaf Power Development.

Savercool Reservoir

Construction of Savercool Reservoir on Mill Creek would block spring-run salmon and steelhead from about ten miles of holding, spawning, and rearing habitat. The reservoir would undoubtedly increase downstream temperatures. A poor trout fishery is about the best that could be expected in the reservoir. Stream surveys indicate that considerable anadromous salmonid habitat exists above Black Rock. Because of the loss of steelhead and spring-run salmon habitat, the Department of Fish and Game would oppose construction of Savercool Reservoir.

Probable Effects of Projects upon Wildlife

The following sections predict the effects of proposed projects on wildlife in the Mill and Deer Creek drainages. The wildlife populations quoted were determined on a reconnaissance level and will require further study at feasibility level. Mitigation and enhancement proposals would also need additional study if a feasibility investigation is authorized.

Initial Mill-Deer Project

The Initial Mill-Deer Project would have serious effects upon wildlife. These effects and possible mitigation methods are discussed.

Morgan Springs Diversion and Conduit

Morgan spring Diversion will affect a small area of little importance to wildlife. Conversely, the conduit from this diversion to Deer Creek Meadows will cross a major deer migration route. The area between Butt Mountain and Mineral is crossed by about 10,500 deer during fall and spring migrations. In addition, the conduit will run through or adjacent to fawning areas with summer deer use averaging as much as 60 deer per square mile; therefore, the method of water conveyance becomes very important. Three conveyance methods were evaluated.

1) Conveyance by closed, buried conduit:

A closed, buried conduit is strongly recommended for conveying water to Deer Creek Meadows Reservoir because it would have little detrimental effect on wildlife.

2) Conveyance to and release down Gurnsey Creek:

Diversion via Gurnsey Creek would create wildlife problems in the possible canal section from Mill to upper Gurnsey Creek. Fawn losses may occur in the creek and could be somewhat greater than under natural conditions.

3) Conveyance by canal:

Examination of three possible canal designs indicated that conveyance of the proposed amounts of water would create undesirable crossing conditions. These conditions would occur at times and quantities that would make them extremely hazardous to migrating deer and young fawns. If future consideration is given to canal conveyance, the canal should be provided with deer-proof fencing and crossings should be installed at quarter mile intervals. Maintenance of the fencing and crossings would be a deciding factor in their effectiveness. A canal would also destroy a certain amount of wildlife habitat that would require mitigation. A canal with crossings would channel migrating deer through a limited number of openings, making them more vulnerable to hunters. High wildlife values occur here and the project should create as few changes in established wildlife patterns as possible and provide adequate mitigation where changes are necessary.

Deer Creek Meadows Reservoir

Mitigation for loss of 680 acres of meadow will be required. Meadowland is limited and is particularly valuable to wildlife. Sufficient land should be purchased and converted from lodgepole pine to meadow to create an enviornment similar to that being lost. This will necessitate selection and development of land having stream and spring associations. To provide replacement habitat for the same deer herd, mitigation should take place in the Childs Meadows, Lost Creek, or Upper Feather River areas. Development would consist of clearing, fencing, water control, and possibly planting. Upon completion of development, these lands would be operated and managed for wildlife at project cost. Provisions should be included to protect the wildlife interests for which the land was developed. If sufficient land suitable for conversion to meadow is not available, adjoining meadowland should be fenced to control livestock use.

Acquisition, clearing, and fencing of 680 acres of private land may be required. Otherwise, some public lands might be developed for this purpose.

Ishi Diversion and Conveyance

Ishi Diversion is not expected to have any adverse effects on wildlife. The conveyance canal to Crown Reservoir will be constructed as a fish spawning channel and will be fenced to exclude livestock. A crossing should be built to provide access between the hills and Deer Creek below the diversion. With the small numbers of wildlife in this area, one crossing would probably be adequate. Below the fish-spawning channel, the water will be conveyed by canal. This canal will be unsafe for wildlife, but the small numbers involved would not merit extensive protection. Two devices should be installed to permit animals to escape from the canal. There should be an occasional access bridge across the canal. Development of the spawning channel with water, trees, and shrubs will develop some additional wildlife habitat.

Crown Reservoir

The wildlife use in Crown Reservoir area is limited and no maintenance is required. The reservoir will provide a resting area for waterfowl. An estimated 543,000 waterfowl-days-use will occur annually. This will contribute to the welfare of the waterfowl population and create a value equivalent to 210 hunter-days. The bulk of the hunting use will be goose hunting.

Waterfowl habitat enhancement possibilities consist largely of creating conditions favorable to the growth of waterfowl food plants. The excavation of borrow materials to create a long pit at the high water line in which the water level can be held essentially constant while the reservoir water level drops would accomplish this objective. Further provisions to develop or provide for marsh conditions on the exposed area below the borrow pit would increase the waterfowl food production. The portions developed for wildlife should be isolated from intensive public use areas; however, hunting should be permitted.

Sugarloaf Power Development

Sugarloaf Reservoir sites lies on Deer Creek at an elevation of 2,860 feet near the upper levels of the deer winter range. A total of 310 acres will be inundated. Deer Creek flows through the area providing some riparian vegetation.

The area is used by several wildlife species including deer and quail. Destruction of this habitat will directly effect wildlife. Mitigation can best be achieved by protection and development of stream-side habitat in the area through a protective easement of 80 acres of adjoining private lands and agreement of public lands. These lands should be retained in a desirable form of limited land use. Replacement of deer winter range would require the development and management of chaparral and mixed woodlands adjoining the reservoir site.

This project includes provisions for a hydroelectric development. A water conveyance system runs through deer winter range and crosses areas subject to heavy deer movement. The depth and flows of water expected here would be unsafe for deer attempting to cross. This water should be transported by closed conduit. If an open canal is used, it should be fenced and bridged to prevent animals from falling into the canal and provide adequate opportunity for crossing. Vigilant maintenance of this fence would be necessary. Suitable fenced crossings should be provided every quarter mile unless further studies show that fewer crossings might be adequate.

Savercool Reservoir

Savercool Reservoir site lies at the 2,400-foot elevation in close proximity to the upper edge of the deer winter range. About 105 acres would be inundated. Mill Creek flows through the area and the meadow contains permanent springs. Blackberry thickets occur on the meadowland.

This reservoir site hosts several forms of wildlife such as deer, quail, bandtailed pigeons, and others. Some prime habitat will be inundated or occupied by intensive recreation. Deer use of this area is frequently heavy. Development and managment of adjacent lands would mitigate for the loss of deer winter range. Control of adjacent land development via easement along Mill Creek above the reservoir site would mitigate for losses other than winter range.

Service Areas

Agricultural service areas supplied water by these projects will experience some land use changes. These changes will affect wildlife to some extent, particularly increasing pheasant habitat.

CHAPTER 5. THE BIG CHICO-BUTTE PROJECTS

Descriptions of Possible Developments

Of the several projects studied within these two drainages (Plate 3), only the Jonesville Project on Butte Creek appeared to be likely for near future construction. A relatively detailed description of the Jonesville Project and brief descriptions of the other projects are presented below.

Jonesville Project

Jonesville Reservoir would be created by a 178-foot dam on Butte Creek in Section 14, T26N, R4E. The reservoir would provide water conservation, fishery enhancement, and recreation benefits. The project would include a ten-foot diversion dam at Butte Meadows and a diversion canal to convey water to Big Chico Creek. The diversion dam would be located in Section 28, T26N, R4E at an elevation of 4,360 feet.

Jonesville Reservoir would impound 42,000 acre-feet of water (elevation 5,027) and cover approximately 450 acres. The reservoir would contain 7,000 acre-feet at dead storage (elevation 4,930), and would include 60 surface-acres. Reservoir drawdown would reach a maximum of about 60 feet.

Water developed by Jonesville Reservoir would be used primarily for domestic water supply. Flows between Jonesville Dam and Butte Creek diversion at Butte Meadows would be increased during the summer and would provide improved trout habitat. The demand schedule for domestic waters would be relatively uniform.

Other Projects

Three other possible projects within the area were studied. These were the Forks of Butte-Barrier and Castle Rock Projects on Butte Creek and the Web Hollow Project on Big Chico Creek. Since all appeared to be engineeringly infeasible, fish and wildlife studies were terminated.

Forks of Butte-Barrier Project. This multiple purpose project was studied as an alternative to the Jonesville Project. It would consist of a 57,000 acre-foot reservoir impounded by a 265-foot dam on Butte Creek in Section 27, T24N, R3E. Project purposes include water conservation, hydroelectric, flood control, and recreation benefits. Barrier Reservoir, a reregulating afterbay formed by a 120-foot dam in Section 5, T22N, R3E, would be an integral part of the power project. Because of the limited power revenue value and anadromous fishery problems, the Jonesville Project was selected in lieu of this development.

Castle Rock Project. Another multiple purpose project studied included the 100,000 acre-foot Castle Rock Reservoir on Butte Creek. The 173-foot dam would be located in Section 25, T22N, R3E. The purposes of this project would include hydroelectric power, flood control, Delta yield, and recreation benefits. Again, fish and wildlife problems, coupled with low power revenue benefits, were instrumental in finding the project economically unjustified at the present time.

Web Hollow Project. This project would include a 13,330 acre-foot reservoir on Big Chico Creek. The 160-foot dam would be located in Section 5, T24N, R3E. The primary purpose of the project would be to provide water for domestic use. The project was not considered to be suitable for near future construction.

Probable Effects of Projects Upon Fish

Only those projects which appeared to be suitable for near future construction are evaluated in detail. The effects of the other projects are discussed briefly.

Jonesville Project

This reservoir would inundate almost five miles of trout stream, including two miles of Colby Creek, one mile of Willow Creek, and one and one-half miles of Butte Creek. These streams support large numbers of brown trout. That portion of Butte Creek which would be inundated also sustains a good population of rainbow trout. Summer water temperatures and streamflows within the reservoir site are ideal for trout production. Temperatures observed at the Jonesville damsite in 1964 ranged from 50 to 60 degrees.

The stream fishery lost through inundation would be replaced with a good reservoir trout fishery. Sufficient spawning and nursery area is available in tributaries above the reservoir site to support appreciable natural reproduction and recruitment to the reservoir. This would reduce the amount of artificial propagation required to maintain a satisfactory reservoir fishery.

Spring-run king salmon spend the summer in deep pools on Butte Creek between Centerville Powerhouse and Parrott-Phelan Dam. They spawn in late September and October. Water temperatures in that area during June, July, August, and September approach the maximum tolerable limit and any significant increase in water temperature during that period could be disasterous to the run.

Final reservoir sizing and operation would have a great influence upon water temperatures available for downstream releases. Preliminary calculations indicate that it would be possible to roughly equal inflow temperatures providing proper consideration is directed to solving potential water temperature problems during the final design stages. Preliminary temperature studies indicate that the normal pool should contain at least 45,000 acre-feet assuming the reservoir would fill in the spring of each year. The dam should include multiple outlets.

The project would provide higher summer flows in the three miles between Jonesville Dam and the Butte Meadows Diversion Dam which would produce improved trout habitat. The potential improvement was not evaluated.

Maintenance Requirements. Requirements to insure the preservation of the fish resources in Butte Creek are enumerated below. Maintenance recommendations for the unjustified projects were not included.

1) Further alteration of flows in Butte Creek could create serious problems for trout and salmon; consequently, fishery

maintenance flows were prepared for three points on the creek. The preliminary flows by area are listed below.

<u>Butte Meadows Diversion Dam</u>

May and June: 150 cfs or the natural flow, whichever is less.

July through April: 100 cfs or the natural flow, whichever is less.

<u>Centerville Powerhouse</u>

Jan. - May: 400 cfs[1/] or the natural flow[2/], whichever is less.

June - August: 250 cfs or the natural flow, whichever is less.

Sept. - Dec.: 150 cfs or the natural flow, whichever is less.

<u>Below Western Canal Crossing</u>

Jan. - April: 400 cfs or the natural flow, whichever is less.

May - June: 250 cfs or the natural flow, whichever is less.

July - Dec.: No recommendation at this time.

2) Multiple outlets would be necessary to select water of proper temperature from the reservoir for downstream releases. The temperature of the downstream release should equal or be less than the temperature of the inflowing water, particularly from April through November.

3) A minimum pool of 15,000 acre-feet should be retained at Jonesville Reservoir to support the fishes residing in the lake and provide temperature control. Such a pool would cover about

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1/ This amount might be increased or reduced depending upon salmon transportation requirements through the Butte Sink.

2/ Natural flow, as used here, would include all existing imports from the West Branch, Feather River.

140 acres with an average depth of about 107 feet. The reservoir trout fishery probably would not be entirely self-supporting, consequently, a planting program would eventually be necessary to maintain a satisfactory level of angling.

Enhancement Opportunities. Means of enhancing fishery resources in Butte Creek with the Jonesville Project are discussed below. Much of the potential improvement would be derived from the trout fishery in the new reservoir.

1) Reductions in water temperatures, increases in summer and fall flows, and improvements of screen and ladder facilities are among the ways by which the anadromous fishes in Butte Creek can be enhanced. Another important enhancement feature might be channel improvements in the salmon spawning area. Increased summer and fall flows accompanied by temperature reductions could improve conditions for trout in upstream portions of Butte Creek.

2) Jonesville Reservoir would be expected to produce a good trout fishery for rainbow and brown trout. A few brook trout could also be expected in the reservoir. It would not be unreasonable to expect a yield of 20 pounds of trout per acre from the reservoir. Assuming an average pool of 350 acres during the peak angling season and the trout growing season, the reservoir would yield approximately 7,000 pounds of trout and support about 14,000 angler-days annually.

3) A limited amount of trout habitat improvement might accrue to larger summer releases of cold water in Butte Creek. The amount of any such increase was not determined.

Forks of Butte-Barrier Project

The Forks of Butte-Barrier Project appears to present spring-run king salmon in Butte Creek with a serious temperature problem. Preliminary temperature studies reveal that in most years the demand for cold water would exceed the supply by late September. Even though the evidence is scanty, it warrants a much more intensive study by a competent temperature prediction expert.

A relatively poor warmwater fishery is about all that could be expected in Forks of Butte Reservoir. If temperatures and other conditions prove suitable, a few trout may utilize the reservoir.

Castle Rock Project

This project would destroy approximately five and one-half miles of holding and spawning area for spring-run king salmon in Butte Creek. The area to be inundated comprises about 75 to 80 percent of the total holding and spawning area available; consequently, holding and spawning facilities capable of supporting 5,000 spring-run king salmon would be required to compensate for habitat losses.

Because of the reservoir morphometry and other factors, the reservoir would not support an outstanding fishery. The reservoir would undoubtedly stratify thermally, with upper, warmer water more suitable for warmwater species and cooler water within the thermocline more favorable for trout.

Temperatures do not appear to be a problem if multiple outlets are incorporated in the dam and the project is properly operated. The amount of water withdrawn from the reservoir between June 1 and December 1 should be limited to avoid downstream releases that would be too warm.

Web Hollow Project

In addition to inundating about two and one-half miles of trout habitat, this small project possesses a potential for destroying the remnants of spring-run salmon and steelhead runs in Big Chico Creek. Even though summer temperatures are marginal, the stream temperatures drop sufficiently by late September to permit salmon to spawn successfully. Any significant downstream temperature increase between June 1 and December 1 could eliminate spring-run salmon. The juvenile rearing capacity could also be greatly reduced by the project.

A larger reservoir might provide suitable downstream temperatures depending upon project operation. In any event, multiple outlets would be required on the dam. A temperature prediction study would also be required.

The reservoir fishery would be dominated by warmwater species and would probably rate as poor. A few trout might occupy the thermocline during the summer months; however, fishing success for them would probably be limited because of the difficulty of fishing at the required depth.

Probable Effects of Projects Upon Wildlife

Each of the projects proposed for the Big Chico-Butte watersheds will affect wildlife as indicated below. The wildlife evaluations and mitigation proposals for these projects were studied to reconnaissance standards and further study will be required to bring them to feasibility level.

Jonesville Project

This project will inundate approximately 420 acres of wildlife habitat at the 5,000-foot level. This habitat consists of an estimated 100 acres of marsh and meadow lands and 320 acres of timber and brush lands of particular value to wildlife. Additional habitat, used by many species of wildlife, will be lost through recreation, road, and borrow pit developments. Meadows in this area support numerous deer during the summer months with estimates of deer use on meadow land ranging up to 73 deer-days use per acre or a total of 7,300 deer-days use on the estimated 100 acres of meadow. Adjacent brush areas also show evidence of heavy deer use. Wildlife use of the reservoir will be limited because of other conflicting uses.

Mitigation for 100 acres of meadow and marsh land will be required. Meadow and associated lodgepole pine land adjacent to the reservoir site should be developed and managed for wildlife. Meadows exist on Willow and Colby Creeks that would partially meet the requirements. About 170 acres of private land, some possibly within the take line, would be required. Development would consist of clearing and fencing the land and possible development of the meadows by silt control and planting. Additional public lands some distance from the reservoir site could be used to provide the additional amount of mitigation required. The necessary private lands should be acquired, developed, and managed for wildlife with control of grazing.

Web Hollow Project

This reservoir will eliminate 230 acres of mixed hardwoods and conifers at the 2,250-foot elevation. Additional habitat would be lost as a result of recreational development. The reservoir site lies within deer winter range. Mitigation for wildlife losses might be partially replaced by managing black oak stands to increase acorn production. Opening of other types of adjacent woodlands would promote growth of browse species to increase the carrying capacity. Maintenance of these woodlands would be required.

Other wildlife should benefit from the mitigation program for deer. Grey squirrels, mountain quail, songbirds, and furbearers use the area to some degree.

Forks of Butte-Barrier Project

Construction of Forks of Butte Reservoir will inundate 520 acres of wildlife habitat. The reservoir lies in a canyon at 2,350 feet elevation making it particularly valuable to deer during winters of heavy snowfall. Examination of the area reveals evidence of heavy deer use. Deer, squirrels, bandtailed pigeons, quail, songbirds, and furbearers are known to use the area.

Elimination of this habitat by the project can be partially mitigated by suitable management of shrubland and woodland adjacent to the reservoir. Additional land would be required in the event of extensive recreation development.

The 75 acres of wildlife habitat that will be destroyed by Barrier Reservoir supports wintering deer, squirrels, quail, furbearers, and songbirds. Mitigation for loss of deer habitat would partially provide for other species.

Due to the limited size of this Barrier Reservoir and its association with Forks of the Butte Reservoir, it would be advisable to expand the mitigation project in that area, rather than attempt on-site mitigation.

Castle Rock Project

Castle Rock Reservoir will eliminate an estimated 1,000 acres of valuable wildlife habitat. An additional 500 acres of poor habitat will be inundated and lands devoted to intensive recreational use will be lost to wildlife. Quail, squirrels, furbearers, songbirds, and other wildlife use the area in significant numbers. The acquisition and management of selected land would provide on-site mitigation.

The reservoir will decrease flooding peaks and frequencies in the Butte Basin thereby decreasing the basin's value to wildlife. The wildlife losses in the Butte Basin caused by this project are not readily measurable, but are of considerable importance. Continued loss of wildlife habitat due to flood protection from many different upstream projects will eventually eliminate a large portion of the wildlife values in the Butte Basin and yet be largely unmeasurable in individual project effects. An overall study of the Butte Basin to assess the effects of all upstream projects is recommended.

Service Areas

A reservoir in this watershed is expected to supply domestic water to the Cohasset Ridge, Forest Ranch Ridge, and Eden Ridge areas. Approximately 11,300 acres of land will be supplied water and permit the development of residential areas with a capacity of 48,000 people. This will decrease deer habitat. Deer will continue to use these areas creating depredation problems. The hunting that now occurs will be greatly reduced or eliminated.

Water for these service areas probably will be conveyed by canals which will traverse areas used by deer for winter range, summer range, and migration. The canals serving Forest Ranch Ridge and Cohasset Ridge will carry water in small amounts and will be reasonably safe for wildlife. Some simple crossings may be required. The canal running to Eden Ridge will carry water in quantities that will create unsafe crossing conditions for wildlife. Closed conduit conveyance would be desirable because wildlife hazards would be eliminated. The canals will have to be fenced to exclude deer and crossings will have to be provided at intervals of every one-quarter to one-half miles. Vigilant maintenance of the fence and bridge structures would be necessary to insure their effectiveness. Further study might indicate that fewer, properly located crossings would be satisfactory.

CHAPTER 6. THE ANTELOPE BASIN PROJECTS

Descriptions of Possible Projects

The Antelope Basin study area included the drainages of Inks, Paynes, Salt, Antelope, and Little Antelope Creeks (Plate 4). Eight possible projects within the area were studied; however, only the Wing Project on Inks Creek and the Belle Mill Project in the Antelope Creek drainage appeared to be suitable for near future construction.

Wing Project

This project would be comprised of Wing Dam and Reservoir on Inks Creek in Section 25, T29N, R3W and Paynes Diversion on Paynes Creek in Section 3, T28N, R2W. Wing Dam would rise 192 feet and impound 244,000 acre-feet. Paynes Diversion would divert Paynes Creek water into Wing Reservoir via gravity canal. Another diversion might be constructed on Battle Creek near the confluence of the North and South Forks.

At normal pool elevation (500 feet), Wing Reservoir would cover about 3,750 acres. Dead pool would include 5,000 acre-feet at an elevation of 360 feet and cover a surface area of 250 acres. Maximum vertical drawdown would be 135 feet.

The project would provide water conservation, recreation, and fish and wildlife benefits. Water would only be withdrawn from the reservoir during critically dry years. In other years, the reservoir level would drop about five feet due to evaporation and would refill the following winter. Through a 40-year operation period, the reservoir would be drawn down only once for a seven-year period. Water released during that period would have been exported to the Delta.

Belle Mill Project

The Belle Mill Project consisted of a diversion dam on Antelope Creek, approximately one-half mile above the existing Coneland Water Company Dam and Belle Mill Reservoir, an off-stream storage impoundment. The project would provide flood control, water conservation, and recreation benefits. Fishery and wildlife enhancement would also be included.

Belle Mill Reservoir would be formed by a 40-foot dyke-type dam in Section 11, 13, and 14, T27N, R3W. Salt Creek would also enter the reservoir. The dam would be about two and one-half miles long. At normal pool elevation of 302 feet, the reservoir would contain 15,800 acre-feet and cover a surface area of 1,120 acres. Dead pool would include 1,800 acre-feet at elevation 284 feet and would cover 190 acres.

Peak flows in lower Antelope Creek would be reduced by the project. With a flow of 24,000 cfs at the diversion site, 16,000 cfs would be diverted and 8,000 cfs would be released downstream. After the flood season the reservoir would be filled to provide a recreation area during the summer month.

Other Projects

Alternative projects studied within the basin included the Facht, Hogback, and Cone Grove Projects on Antelope Creek, the Tuscan Project on Salt Creek, and the DeHaven Project on Little Antelope Creek. All of these were studied as alternatives to the Belle Mill Project.

Facht Project. Facht Reservoir would be created by a 260-foot dam on Antelope Creek in Section 5, T27N, R1W (Plate 4). The project would provide flood control, water conservation, and recreation benefits. At normal pool elevation (1,040 feet) the reservoir would contain 75,000 acre-feet of water covering a surface area of 715 acres. Dead pool would include 5,000 acre-feet at elevation 870 feet and cover 125 surface acres. Maximum vertical drawdown would be 170 feet.

Hogback Project. This alternative project consisted of Hogback Dam and Reservoir, also on Antelope Creek. The 230-foot dam would be located in Section 9, T27N, R2W. Flood control, water conservation, and recreation were among the project purposes. At normal pool elevation (660 feet) the reservoir would impound 30,500 acre-feet. Approximately 385 acres would be inundated by the reservoir. The dead pool would include 2,500 acre-feet and cover 65 acres. Dead pool elevation would be 520 feet, yielding a maximum drawdown of 140 feet.

Cone Grove Project. Cone Grove Reservoir, an alternative to Belle Mill and in essentially the same location, would be impounded by a four and one-half mile levee about 77 feet high in T27N, R3W. Salt, Little Salt, and Antelope Creeks would enter the reservoir. Purposes of the project include flood control, water conservation, and recreation.

The 102,000-acre-foot normal pool would cover 2,660 surface acres at an elevation of 350 feet. Maximum vertical fluctuation would be 45 feet down to an elevation of 305 feet. Dead pool would include 12,500 acre-feet and cover 1,350 acres.

Tuscan Project. Tuscan Dam would be located on Salt Creek in Section 33, T28N, R2W. The 140-foot dam would provide flood control, water conservation, and recreation benefits. At a normal pool elevation of 755 feet, the 13,000-acre-foot reservoir would cover 275 acres. With a maximum vertical drawdown of 85 feet, a dead pool storage of 800 acre-feet would remain and cover 40 acres at an elevation of 670 feet.

DeHaven Project. This project would be located on Little Antelope Creek in Section 21, T27N, R2W. The 150-foot DeHaven Dam would provide flood control, water conservation, and recreation benefits. At normal pool (elevation 520 feet) the 10,000-acre-foot reservoir would inundate 185 acres. Dead pool would contain 600 acre-feet and cover 30 acres at an elevation 420 feet. Maximum drawdown would be 100 feet.

Probable Effects of Projects Upon Fish

Again, only the effects of those project which are suitable for near future construction are discussed in detail. The Wing Project on Inks Creek and the Belle Mill Project were the only projects which met that criterion.

Wing Project

The Paynes Creek Diversion would block the upstream migration of a small run of steelhead trout unless precautionary measures are taken. The actual size of the run is unknown; however, the number of fish involved should be determined prior to completion of feasibility studies. Assuming the run is significantly large, fish passage should be provided over the diversion dam. A transportation flow would also be required from October through May for upstream and downstream migrant steelhead. The diversion should be screened. If a diversion were constructed on Battle Creek, similar fish protection features would be required and the effects of the diversion more fully explored.

Wing Reservoir, with the proposed operation plan, would support an excellent warmwater fishery. The relatively stable reservoir would be very conducive to fish production except during the few years when drastic drawdowns would occur. Based upon an average surface area of 3,500 acres and an estimated yield of 20 pounds per acre, the reservoir could yield 70,000 pounds of fish and support 70,000 angler-days. The project sponsor should stock the reservoir with warmwater gamefish at a cost of about $5 per surface-acre of $18,750. Restocking would be desirable following drawdowns to less than 25,000 acre-feet. A minimum pool of 5,000 acre-feet excluding silt storage, should be retained to support a few brood fish during extreme drawdown periods.

Maintenance Requirements - The following maintenance recommendations are prescribed to protect fishlife:

1) Fish passage and screening facilities should be constructed at the Paynes Creek Diversion Dam, providing further studies indicate they are warranted.

2) A fish transportation flow of 30 cfs or the natural flow should be released below the Paynes Creek Diversion Dam from October through May.

3) Further study would be required to determine the need for facilities and flows at a possible Battle Creek Diversion.

Enhancement Opportunities - New fish habitat could be produced by:

1) Construction of Wing Reservoir and a stable reservoir operation could provide a warmwater fishery capable of supporting 70,000 angler-days.

2) A minimum pool of 5,000 acre-feet, excluding silt storage should be retained to support fish during years when drawdowns occur.

3) The project sponsor should initially stock Wing Reservoir with warmwater gamefish at a cost of $18,750 and restock the reservoir after severe drawdowns to less than 25,000 acre-feet.

4) Selective retention of vegetation within the reservoir area might significantly increase the yield to the fishery.

Belle Mill Project

The Belle Mill Diversion Dam on Antelope Creek could create serious problems for anadromous salmonids. Adequate screens and ladders would be required at the diversion and a fishery maintenance flow would be required below the diversion.

Belle Mill Reservoir would support a limited warmwater fishery, even though its primary purpose would be flood control. The streams entering the reservoir are rich in minerals. The reservoir would be kept at a flood pool of 2,000 acre-feet between October 1 and March 1, after which the reservoir would store water to fulfill other commitments. The reservoir would reach its highest level about the first of June and would drop rapidly during September.

Further studies should be conducted to determine if carp and other non-game fish are present in Antelope Creek above the proposed diversion site. If so, an eradication program should be undertaken to eliminate them from the creek and Belle Mill Reservoir.

Construction of a controlled-flow, artificial spawning channel might be possible with construction of this project. That possibility should receive further consideration if a feasibility study is conducted.

The project sponsor should stock the reservoir initially with warmwater gamefish. Estimated stocking costs would be about $5 per surface-acre or $5,600. The flood pool would only support a small population of fish, thus increasing the minimum pool could result in a substantially improved fishery. Based upon an average pool of 500 acres and a yield of five pounds per acre, the reservoir would yield 2,500 pounds of warmwater fish and support 2,500 angler-days.

Maintenance Requirements - The following requirements should be met to preserve the fish resources of the area:

1) Fish screens and fish passage facilities should be provided at the diversion dam on Antelope Creek.

2) The following downstream releases should be made below the diversion dam to preserve the salmon and steelhead resources of Antelope Creek:

Jan. 1 - May 31:	75 cfs or the natural flow, whichever is less.
June 1 - Sept. 30:	50 cfs or the natural flow, whichever is less.
Oct. 1 - Dec. 31:	100 cfs or the natural flow, whichever is less.

Enhancement Opportunities - The fishery resources of the area could be enhanced by:

1) A minimum pool of not less than 2,000 acre-feet should be provided in Belle Mill Reservoir.

2) The project sponsor should stock the reservoir initially with warmwater gamefish at a cost of $5,750.

3) Further studies should be conducted to determine the desirability and cost of a roughfish eradication program on Antelope Creek above the diversion dam.

4) A plan for the selective retention of vegetation and/or provisions for the addition of brush shelters should be carried out to optimize returns to the fishery.

5) Consideration should be given to the removal of the Coneland Water Company Dam and the subsequent relocation of ditches emanating from the dam. Such a plan would provide more spawning area for fall-run salmon and present spring-run salmon and steelhead with fewer migration difficulties.

6) The entire flow of Antelope Creek below the proposed diversion dam should be restricted to one channel to avoid the stranding of migratory salmonids.

7) Possibilities for constructing an artificial spawning channel should receive further study.

Facht Project

Facht Reservoir would flood approximately five miles of trout and smallmouth bass habitat. High water temperatures during the summer produce marginal habitat conditions for trout, particularly in the lower portion of the area. Summer conditions are nearly ideal for the abundant smallmouth bass. The stream fishery would be replaced by a reservoir fishery, the quality of which would be limited. The reservoir fishery would be dominated by warmwater fish.

Spring-run king salmon and steelhead would be denied access to about 12 to 15 miles of holding, rearing, and spawning habitat above Facht damsite. The area between Facht damsite and the mouth of the canyon could more than compensate for the lost habitat, providing flows and summer temperatures would be suitable. As noted earlier, low flows and high summer temperatures in that area presently preclude its use for holding spring-run salmon and for rearing juvenile steelhead and salmon.

Hogback Project

A preliminary evaluation of the 30,500 acre-foot Hogback Reservoir indicates that the project would create serious temperature problems for salmon and steehead. The reservoir would stratify thermally; however, there would not be sufficient cold water trapped in the reservoir to last through the summer and fall. Complete elimination of spring-run salmon and steelhead could be expected. A few fall-run salmon might be able to spawn successfully after December 1. In essence, the Hogback Project would annihilate the estimated 1,200 to 1,300 salmon and steelhead in Antelope Creek.

All but two miles of the habitat for spring-run salmon and steelhead would be inundated or blocked by the dam. The two miles probably would not provide sufficient habitat to maintain the runs even though they are already small.

Hogback Reservoir would eliminate about three and one-half miles of good small-mouth bass stream fishery. The reservoir would only produce a poor warmwater fishery. The steep, rocky sides of the reservoir would not lend themselves to littoral zone fish food production or spawning. Overall access to the reservoir would be poor and sites suitable for onshore recreation developments are almost totally lacking.

Cone Grove Project

Construction of Cone Grove Dam on Antelope Creek would eliminate fall-run salmon because fall water temperatures would be too high for successful spawning and egg incubation. It would be necessary to trap and transport adult and juvenile spring-run salmon and steelhead around the reservoir. Complete collection of downstream migrants would be practically impossible during high flows.

The reservoir would provide a poor fishery for warmwater gamefish such as catfish, largemouth bass, and panfish. Spawning success and productivity would depend largely upon reservoir operation.

Tuscan and DeHaven Projects

The Tuscan and DeHaven Projects are discussed together because neither would affect any existing fishery resources. Fishery enhancement opportunities accompany these projects because each reservoir would support a warmwater gamefish and preserve sufficient minimum reservoir pools to sustain fish during drawdown periods. Minimum pools and initial stocking costs at Tuscan and DeHaven would be 3,000 acre-feet, $1,375 and 1,500 acre-feet, $925 respectively. Tuscan Reservoir would be fed with mineral-rich waters. A good fishery should develop at Tuscan Reservoir, while that at DeHaven would probably rate only as fair.

Probable Effects of Projects upon Wildlife

The probable effects of possible alternatives upon wildlife are described.

Wing Project

The proposed Wing Reservoir would inundate 3,600 acres of poor rangeland and oak covered, stream bottom lands. Games species include deer, quail, doves, rabbits, and several others, including a few waterfowl during wet periods of the year. Deer use of the area is limited and it is not critical deer range. Wildlife losses in this area would be minor and would be offset by the development.

Operation of the reservoir at a constant level would create desirable wildlife habitat conditions. Waterfowl and shorebirds would would use the area throughout the year. Protection from intensive public use would be required in some areas to provide maximum wildlife values. Special provisions should be made to insure public hunting at the reservoir.

Wing Reservoir would provide an estimated 690,000 waterfowl days use annually contributing approximately 530 hunter-days annually on a statewide basis. In one year out of five, these values will be decreased by 50 percent because of reservoir water surface fluctuation.

The Paynes Creek diversion may inundate some valuable wildlife habitat. Possible losses there should be explored in detail prior to the completion of feasibility studies.

Any appurtenant canals will have to be designed to protect wildlife, or be provided with protection devices such as fencing and bridging.

Belle Mill Project

Belle Mill Reservoir would inundate 1,100 acres of nearly barren land with insignificant wildlife use. Mitigation would not be required. Some wildlife habitat would be created; however, the amount would be determined by reservoir operations. The wildlife habitat enhancement potential of this reservoir should be explored more thoroughly during feasibility studies.

Flood control afforded by this project would have adverse effects on wildlife in downstream areas. These losses are difficult to assess and further study is suggested.

Facht Project

Facht Reservoir site includes 715 acres of wildlife habitat. Antelope Creek flows year-round and food riparian growth exists, including large blackberry thickets. The entire area lies within the deer winter range and portions lie within the Tehama Winter Deer Range, owned and managed for wildlife by the California Department of Fish and Game. The access road to much of the winter range crosses the reservoir site.

Many species of wildlife, including waterfowl, quail, songbirds, and furbearers, use the area and the majority find the stream bottom lands particularly attractive. A permanent water supply with closely associated cover make ideal wildlife conditions. Estimated deer use on the 715 acres ranges from 6,000 deer days use in mild winters to 20,000 in a severe winter when deer are concentrated on the area.

Land would have to be purchased and developed to create sufficient carrying capacity to cover habitat losses. The Department of Fish and Game would assume management of this land in conjunction with its Tehama Winter Deer Range. The project would have to provide all funds for mitigation lands including maintenance costs.

Flood control provided by this project would adversely effect wildlife in downstream areas, although losses would be difficult to measure. Further study of this problem is recommended. Replacement of access to the Tehama Winter Deer Range will be required.

Hogback Project

Hogback Reservoir site lies at the lower edge of the foothills in a steepsided area characterized by poor range consisting of scattered trees and brush. Three hundred and eighty-five acres would be inundated by the reservoir.

Several species of wildlife use this area. A few waterfowl utilize pools in the creek bottom for short periods. Deer use in the reservoir site is estimated at 3,800 to 15,400 deer days use per year depending upon weather conditions and deer herd numbers.

Land adjacent to the Tehama Winter Deer Range should be purchased, developed, and maintained to mitigate for losses. Fencing to exclude livestock would be necessary. The Department of Fish and Game would assume management responsibilities, with maintenance and other funds provided at project cost.

Flood control features of this project would adversely affect wildlife downstream. Further study of this problem is recommended.

Tuscan Project

Tuscan Reservoir site includes 275 acres of valuable wildlife habitat used by several species of wildlife. The area also lies within the deer winter range.

Deer use ranges from 3,000 to 8,000 deer days use per year. The creek botton lands are particularly important to quail, furbearers, songbirds, because of their cover and water combinations in an otherwise dry rangeland habitat.

Mitigation for wildlife losses can best be accomplished by purchase of land adjacent to the Tehama Winter Deer Range. Development required would consist of fencing to exclude livestock and creation of a farm-pond type reservoir. Management and operation of the land would be accomplished by the Department of Fish and Game at project cost.

The reservoir would provide flood control benefits, the effects of which are difficult to measure. The overall wildlife losses extend beyond the immediate project area. Further study of the losses and possible mitigation is necessary.

DeHaven Project

This reservoir site will inundate 185 acres of land used by several species of wildlife. The area lies on the lower portion of the deer winter range. Deer use varies from 3,700 to 7,400 deer days use depending on weather conditions and deer herd numbers.

Mitigation for wildlife losses would require the purchase of land for wildlife management. Land should be purchases adjacent to the Tehama Winter Deer Range and turned over to the Department of Fish and Game for management after fencing the exterior boundary to exclude livestock. Management costs should be borne by the project sponsor.

Flood control features of this reservoir create downstream wildlife losses that are difficult to measure. Further study of these losses and possible mitigation is necessary.

Service Areas

Additional water supplied to service areas by the projects will inevitably result in land use changes. Although the effects of these changes on wildlife are expected to be limited, pheasant habitat will probably increase.

CHAPTER 7. THE BUTTE BASIN PROJECT

Description of Possible Developments

On June 4, 1964, the State Reclamation Board adopted a master plan for the reclamation of land within Butte Basin. The adopted plan consists of three phases. Phase 1 would consist of construction of a low-level levee on the east side of the Sacramento River from Parrott-Grant line to Chico Creek. Main channel capacity in the river would be 120,000 cfs, above which the levee would overtop. At present, overflow begins at about 90,000 cfs.

Phase 2 would consist of raising Phase 1 levees, construction of Chico Landing Weir, control levees to permit Little Chico Creek and Edgar Slough to enter the system, and a levee system on the west side of the Sacramento River to permit Stony Creek to enter. The weir would spill at flows greater than 120,000 cfs.

Phase 3 would add a double levee bypass system to channel floodwaters into the Butte Sink for temporary storage.

Chico Landing Weir

The weir would be a concrete structure approximately one mile long with a crest elevation of 129 feet. The weir would be designed to pass 60,000 cfs into the Butte Basin under a project flood of 210,000 cfs.

The weir would be located about five miles southeast of Chico and about one and one-half miles below the mouth of Chico Creek (Plate 5). The low flow channel of the river would be approximately one-half mile from the weir.

New Bypass System

The third phase of the project envisions a bypass-type channel to convey and restrict floodwaters through the upper part of the Butte Basin. Two levees would be required.

The west bank levee would extend from the end of the weir control levee to the north end of the Reclamation District No. 1004 levee near the Glenn-Colusa County line. The east bank levee would extend from the east weir training levee to the north levee of Cherokee Canal, tying into the Butte Creek levees along the way.

The levees would average ten feet in height with five feet of freeboard. Crown width would be 20 feet. Side slopes would be one on two landside and one on three waterside. The bypass width would vary from 6,000 feet between Ord Ferry Road and Butte Creek to 6,500 feet between Butte Creek and Cherokee Canal. Designed capacities would be 60,000 cfs at the weir and 70,000 cfs from Butte Creek to Cherokee Canal. Bypass operation would be similar to the operation of Sutter and Yolo Bypasses.

Probable Effects of Project Upon Fish

Phase 1 of the adopted master plan would have very little effect upon fish. Frequency of spills into Butte Basin would change slightly. Borrow pits for the low levees probably would be extensive enough to warrant the development of warmwater fishing potential.

Construction of Chico Landing Weir and completion of Phase 2 would present some problems for anadromous salmon and steelhead. The stilling basins commonly associated with bypass weirs provide attractive resting places for salmon and steelhead and they often become stranded as river stages recede and flow over the weir ceases. As an example of the magnitude of such losses, about 650 salmon were rescued at Fremont Weir in January 1965. An estimated additional 800 fish were lost. Losses also occurred at Moulton Weir.

The possibility of salmon and steelhead being attracted into Little Chico Creek and Edgar Slough presents a problem. These streams are intermittent and any fish entering them would inevitably be lost. On the other hand, reduction or elimination of spills between the Chico Landing Weir and Moulton Weir would reduce the attraction into Angel Slough and other neighboring waterways. Borrow pits associated with the control levees could provide new habitat for warmwater gamefish if permanent pools were maintained.

The effects of Phase 3 would include those of Phase 2 except that anadromous fish would no longer be attracted into sloughs entering the basin from the west. Conversely, fish would be more readily attracted to the outflow of Cherokee Canal. Problems would also be expected where Butte Creek enters the bypass. Spring-run salmon intended for Butte Creek should be able to enter and proceed upstream. Salmon and steelhead destined for the Sacramento River system above Chico Landing, particularly winter-run salmon, should be provided passage through the bypass and back into the river.

Completion of Phase 3 could create an enormous amount of new warmwater gamefish habitat in the levee borrow pits. Public fishing areas could be developed and extend the entire length of the bypass or about 20 miles. The borrow pits along the Sutter Bypass emphasize the potential because they are some of the most heavily fished waters in California, even though no planned facilities are present. With proper development, the intensive use of the area would not conflict with its primary purpose -- flood control.

Maintenance Requirements

Phase 1 of the adopted master plan would not create any serious fish losses. To the contrary, it may eliminate some losses because of the reduced frequency of flooding in that area. A small but significant number of anadromous fish are lost during minor flooding.

Phase 2 will create problems for migratory salmonids similar to those experienced at Fremont Weir last winter. To avoid similar problems, it is recommended that:

1) The Chico Landing Weir should be provided with a suitable fishway at each end.

2) The weir stilling basin should be designed to permit fish to move from one end to the other when there is little or no overflow.

3) Borrow areas along the control levees between Ord Ferry Road and Chico Landing Weir should have continuous channels connected with the stilling basin and leading to the fishway entrances.

4) The need for some type of fish barrier to prohibit fish from entering Little Chico Creek and Edgar Slough should be investigated.

Phase 3 would present essentially the same problems as Phase 2 in addition to a few others. Fishway and stilling basin requirements would be the same. Other recommendations are:

1) The continuous borrow pit channels should extend to the southern extremities of the new levees.

2) The low flow channel of Butte Creek should be connected at both ends with the borrow pit channel along the east levee.

3) The necessity for fish barriers at the outflows of Cherokee Canal, Little Chico Creek, and Edgar Sloughs should be investigated.

Enhancement Opportunities

Phase 1 of the adopted plan appears to possess little fishery enhancement potential. Phase 2 could provide new habitat for warmwater gamefish if sufficient water remains in the borrow channels through the summer. Any enhancement benefits should be accompanied by assured public access, parking and other facilities. Phase 3 could provide a large amount of warmwater fishery enhancement in the lengthy borrow pits along each levee. Similar waters in the Sutter and Yolo Bypasses provide some of the best catfish fishing in the State, as well as excellent angling for other warmwater species.

Borrow channels on each side of the bypass should be contiguous. The area should be acquired to assure public access. A development plan including picnic areas, parking areas, and boat launching areas should be prepared by the Department of Parks and Recreation in cooperation with the Department of Fish and Game. Invert controls should be located at appropriate intervals to provide a continuous waterway on each side of the bypass. Riparian vegetation should be permitted to encroach upon the channels to the maximum extent possible without interfering with flood control functions. Unless proper precautions are taken during the design phase, rooted aquatic vegetation within the channel could limit the potential fishery. Finally, a detailed fishery management plan should be prepared.

Probable Effects of Project Upon Wildlife

Sizeable wildlife values in the Butte Basin will be affected by the proposed flood control plans. The Butte Basin, a natural sink and flood overflow area, lies east of the Sacramento River between Chico Landing on the north and the Sutter Bypass on the south. The eastern boundary is an indefinite line along the gently sloping lands rising from the trough of the basin toward the Sierra Nevada foothills. The basin is about 40 miles long and up to 13 miles wide, encompassing an area of about 270 square miles. During high water periods, large portions of the basin are inundated. The natural flooding of this basin makes it one of the principle waterfowl wintering areas in the Pacific Flyway. During peak production years nearly three million waterfowl use the basin during the winter months. Up to 25 percent of the waterfowl on the Pacific Flyway winter here. In addition, wintering shorebirds and nongame birds swell the wildlife populations. Resident species are numerous with pheasants numbering better than 50 birds per 100 acres. Hunting is a major activity in the basin with large areas dedicated solely to this purpose. Loss of this habitat will seriously affect the wildlife resources of the State. The basin is divided into upper and lower basins by Gridley road.

The lower Butte Basin, lying south of Gridley Road, is a natural floodwater sink. Some of the most heavily used waterfowl areas in the State occur within the lower Butte Basin. Its value as waterfowl habitat is expressed by the existence of the best duck clubs in the State. They occupy most of the sink. Thousands of acres are flooded annually for waterfowl prior to flood periods and, thereby, dedicated exclusively to wildlife. The State-owned Grey Lodge Waterflowl Management Area, managed for waterfowl by the California Department of Fish and Game, lies partly within this area. The lower basin receives floodwater from the upper basin, Butte Creek and Colusa and Moulton Weirs. Flows from all of these are expected to continue with a decrease in water coming from the upper basin. Presuming the proposed flood control projects will not affect the lower basin, no maintenance is suggested at this time; however, any changes adversely affecting the lower basin would do serious harm to valuable wildlife habitat and would warrant additional study.

The upper Butte Basin consists largely of agricultural lands interspersed with natural vegetation and waterways. The entire area has been historically subject to flooding at high flows in the

Sacramento River. As a result, many areas of natural vegetation and waterways have remained in a wild state. Interspersed with agriculture, these areas provide some of the best wildlife habitat conditions found in the Sacramento Valley. Periodic flooding has also made large areas of agricultural lands available to wintering waterfowl. Land use in the area has adjusted to periodic flood conditions resulting in continued high quality wildlife habitat.

Present conditions permit some flooding almost every year. Phase 1 would decrease both the frequency and volume of flooding in the upper basin. The flooding that would occur will flow over the area largely as it does now. Flood frequency should change from flooding most years to once every two and one-half years. Flooding of lands adjacent to waterways would occur once in five years, instead of every year and one-half. General flooding would occur once in ten years instead of about once every three years. Under these conditions, land use would change from wildlife habitat conditions to intense agricultural conditions. Flood control provided by this project would lead to land use changes on approximately 11,900 acres. These changes would involve shifts from rice, field crops, grain, pasture and native vegetation to orchard, truck and miscellaneous crops which have low wildlife values. The overall effect would be sizeable losses of wildlife habitat. Some of these values may be lost in time, but flood control is required to accelerate the change. The constant trend to convert natural wildlife habitat to agricultural uses is being held back by flood-caused conditions.

Phase 2 envisions limiting the initial flow into the basin to one limited area. This would decrease the extent of flooding at lower flood levels. Phase 3 envisions limiting all flood flows, into and through the upper basin, to a leveed bypass. Phases 2 and 3 would each add to and hasten conversion of wildlands to agriculture within the upper basin. Increased land values, taxes, and costs would probably force landowners to eliminate all wildland areas, eventually limiting them to part of the main floodway or bypass channel.

Under any conditions, loss of native vegetation and agricultural crops most desirable for wildlife can be expected to continue wherever land reclamation is feasible. Flood protection will hasten this reclamation and, depending on the degree of control, will eventually eliminate many acres of wild lands in the upper Butte Basin. A large area of rice lands may remain because of soil conditions, but refined agricultural methods may lead to clean cultivation and loss of wildlife habitat.

Under Phase 1, local interests would be permitted to develop the project and little possibility for mitigation of wildlife habitat losses will exist. Under Phases 2 and 3, participation of state and federal agencies would permit mitigation for losses. If Phase 3 is constructed, the following steps should be taken to compensate for habitat losses.

1) The developing agency should purchase all lands and levees within the bypass area.

2) These lands would be dedicated to wildlife habitat and managed by or with the concurrence of the Department of Fish and Game.

3) Portions of the proposed bypass now in agriculture might profitably be leased back to agricultural interests on a short term basis where this benefits wildlife. This would permit changes to more intensive management for wildlife if desirable. The leases should provide for the agricultural use most advantageous to wildlife and limit detrimental practices. Public access for hunting and fishing should be assured.

4) Provisions should be made to provide raised islands within the bypass at intervals sufficient to provide emergency cover for wildlife during times of flooding in the bypass. Tree and brush cover should be permitted to grow on these islands. The bypass should be sized to provide for such islands and riparian vegetation.

5) Provisions should be made to develop and maintain borrow ditches next to both levees. These should be connected to existing channels. Water should be provided to maintain a constant water movement in these ditches and some additional water for crops and seasonal flooding. Public access should be provided at one mile intervals, either by road or foot bridges.

6) Results of studies in the Sacramento-San Joaquin Delta should be utilized to select adaptable vegetative cover to be planted on the levees forming the bypass.

Wildlife interests will be best served by keeping this area in its present state. Otherwise it appears that wildlife might fare better with Phase 3 of the Reclamation Board's Master Plan and full provisions for the necessary mitigation. Additional study will be required before specific mitigation proposals can be finalized.

CHAPTER 8. SUMMARY AND RECOMMENDATIONS

Summary

The Sacramento Valley East Side Investigation area covered a 2,000 square mile area in Butte and Tehama Counties and included the Antelope, Mill, Deer, Big Chico, and Butte Creek drainages, as well as several minor streams. This phase of the investigation was designed to assess the effects of several proposals for water development upon the fish and wildlife within the area.

The fish and wildlife investigations ranged from brief, cursory reviews to fairly detailed studies. Results of these studies were utilized in prescribing measures to maintain and enhance fish and wildlife resources.

Of the many fish and wildlife resources inhabiting the area, the migratory species are generally more important because of their scarcity and demand. Migratory species include salmon, steelhead, deer, mourning doves, bandtailed pigeons, and waterfowl.

All of the major East Side streams support spring-run king salmon and steelhead. With the exception of Butte Creek, all major streams also support fall-run salmon. The threat of extinction facing spring-run salmon in the Central Valley was discussed in Chapter 1.

The investigation area also includes some extremely important wintering habitat for deer and waterfowl. Foothill areas are valuable winter range for the Tehama deer herd. Watherfowl find excellent marshland habitat in the Butte Sink. Wintering geese utilize the Vina Plains for feeding and resting.

There is an abundance of non-migratory species of wildlife throughout the area. Non-migratory deer herds, upland game species, furbearers, and a multitude of songbirds and other birds and mammals of considerable esthetic value depend upon the existing wildlife habitat.

The initial phase of the Mill-Deer Project, including Deer Creek Meadows and Crown Reservoirs, could significantly enhance the fishery resources in Deer Creek provided recommendations outlined in this report are followed. Species benefiting from these projects would include brown and rainbow trout, steelhead, rainbow trout, and spring-run and fall-run king salmon. Several fish and wildlife protection features would be required including some deer habitat mitigation.

The Jonesville Project on Butte Creek possesses a limited potential for enhancing fish population; however, increases in downstream temperatures must be avoided. Otherwise, the spring-run salmon in the creek would be threatened. Fish enhancement would essentially be limited to the new reservoir. Some deer habitat mitigation would be necessary.

The two possible developments within the Antelope Basin, the Wing Project and the Belle Mill Project, are capable of providing new habitat for warmwater fish and migratory waterfowl. Properly operated, Wing Reservoir would provide excellent warmwater fish production and an aquatic enviroment capable of supporting waterfowl populations.

The greatest threat posed by the possible new bypass in the Butte Basin would confront migratory waterfowl. Without more detailed planning, large parcels of habitat could be destroyed forever.

Recommendations

General

1) Any project within the area should give special consideration to its effects upon anadromous fish.

2) Any project proposed on Butte Creek should be studied carefully to insure that stream temperature increases do not annihilate spring-run salmon in that stream.

3) Any project proposed for further study should be subjected to more intensive fish and wildlife investigations.

4) An effective method of controlling stream pollution during construction would be required.

5) Further attention should be devoted to determining the precise streamflow requirements such as flushing and attraction flows.

The Mill-Deer Project

The following maintenance requirements are recommended:

1) Further consideration should be directed toward determining the need for fish passage facilities at Morgan Springs Diversion Dam on Mill Creek.

2) The Morgan Springs Diversion Dam should be a demountable structure and should be removed when water is not being diverted.

3) Fish passage difficulties at Black Rock Falls should be eliminated.

4) The following downstream fishery releases should be made in Mill Creek below the Morgan Springs Diversion Dam:

Dec. 1 - May 31:	35 cfs or natural flow, whichever is less.
June[1/] - June 15:	150 cfs or natural flow, whichever is less.
June 15 - June 30:	150 cfs on June 16 graduated up to 200 cfs or natural flow by June 30.
July 1 - Nov. 30:	Full natural flow.

5) The Childs Meadow Conduit should be closed and screened at each end. The conduit should enter Deer Creek Meadows Reservoir in the immediate vicinity of Gurnsey Creek.

6) A minimum storage of 40,000 acre-feet should be retained in Deer Creek Meadows Reservoir to sustain trout populations during the drawdown period.

7) Further studies should be conducted to determine what roughfish are present in the drainage above Deer Creek Meadows Reservoir and if an eradication program would be necessary.

1/ The effects of diversions during the month of June should be investigated in much more detail during feasibility studies.

8) The design for Deer Creek Meadows Dam should include multiple outlets to permit selection of optimum water temperatures for downstream releases.

9) Extreme care should be exercised during construction of Deer Creek Meadows Dam to avoid downstream silt pollution.

10) Satisfactory fish passage facilities should be provided at Ishi Diversion Dam. Provisions should also be made for leading fish to the facilities.

11) The following releases should be made below Ishi Diversion Dam:

Oct. 15 - Dec. 31:	125 cfs or natural flow, whichever is less.
Jan. 1 - Feb. 29:	100 cfs or natural flow, whichever is less.
Mar. 1 - June 15:	75 cfs or natural flow, whichever is less.
June 15 - Oct. 14:	Existing impaired flow or more.

12) Ishi Diversion Dam should be designed to avoid undesirable water temperature increases.

13) The fall-run king salmon spawning gravels in Deer Creek between Ishi Diversion Dam and the Sacramento River should be acquired by purchase or easement.

14) Yahi Canal should be screened to prohibit downstream migrant salmon and steelhead from entering Crown Reservoir.

15) Further study should be conducted to determine the effects of borrowing construction materials from Deer Creek for Crown Dam.

16) Childs Meadow Conduit should be closed and underground. The alignment should be landscaped by plantings and re-seeding after construction.

17) Mitigation for the loss of 680 acres of meadow habitat for deer and other wildlife would be necessary. Appropriate areas should be acquired, cleared, developed, and managed for wildlife.

There are numerous ways to increase the fish and wildlife resources of the Deer Creek area. Those are listed below:

1) A 25 cfs turnout and delivery of five cfs or more from the Childs Meadow Conduit to Gurnsey Creek would enhance the trout spawning potential in Gurnsey Creek.

2) Further study should be conducted to determine the feasibility of improving trout spawning riffles in Gurnsey Creek.

3) Trout production would be enhanced with the construction of Deer Creek Meadows Reservoir.

4) Spring-run salmon and steelhead trout habitat will be enhanced by increased summer flows and decreased water temperatures in Deer Creek below Deer Creek Meadows Reservoir. The following release schedule was established during the course of this investigation:

Month	Flow in cfs	Flow in acre-feet
October	140	8,600
November	175	10,400
December	150	9,200
January	125	7,700
February	95	5,300
March	50	3,100
April	50	3,000
May	50	3,100
June	50	3,000
July	75	4,600
August	100	6,100
September	100	5,900

5) Fall-run salmon production would be greatly magnified by the construction of an artificial spawning channel in Yahi Canal.

6) Elimination of fish passage problems at Stanford-Vina Dam would measurably increase the production of fall-run salmon, spring-run salmon, and steelhead trout in Deer Creek.

7) Provisions for permanently screening irrigation diversion from Deer Creek would increase the survival of anadromous fish in the creek.

8) A minimum pool of 1000 acre-feet should be retained in Crown Reservoir to support fishlife in the reservoir.

9) The project sponsor should stock Crown Reservoir initially with warmwater gamefish at a cost of approximately $3,650.

11) The project sponsor should support a ten-year post-project evaluation to insure maximum returns in fishery enhancement investments.

12) Development of borrow areas at Crown Reservoir could enhance waterfowl.

13) Crown Reservoir could provide about 543,000 waterfowl days use.

The Jonesville Project

Several requirements should be met to insure the preservation of fish and wildlife resources in the Butte Creek area in connection with the Jonesville Project. Those are enumerated below:

1) Further alteration of flows in Butte Creek could create serious problems for trout and/or salmon; consequently, fishery maintenance flows were prepared for three points on the creek. The recommended flows are listed below.

Butte Meadows Diversion Dam

May and June:	150 cfs or the natural flow, whichever is less.
July through April	100 cfs or the natural flow, whichever is less.

Centerville Powerhouse

Jan. - May:	400 cfs 1/ or the natural flow 2/, whichever is less.
June - Aug.:	250 cfs or the natural flow, whichever is less.

1/ This amount might be reduced depending upon confirmation of salmon transportation requirements through the Butte Sink.

2/ Natural flow, as used here, would include all existing imports from the West Branch, Feather River.

Sept. - Dec.:	150 cfs or the natural flow, whichever is less.

Below Western Canal Crossing

Jan. - April:	400 cfs or the natural flow, whichever is less.
May - June:	250 cfs or the natural flow, whichever is less.
July - Dec.:	No recommendation at this time.

2) Multiple outlets would be necessary to select water of proper temperature from the reservoir for downstream releases. Downstream releases from the reservoir should equal or be less than the temperature of the inflowing water, particularly during the period from May through November. A competent temperature study would be required.

3) A minimum pool of 15,000 acre-feet should be retained at Jonesville Reservoir to support the fishes residing in the lake. The reservoir trout fishery probably would not be entirely self-supporting, consequently, a planting program would eventually be necessary to maintain a satisfactory level of angling.

4) An effective method of controlling stream pollution during construction would be required. Siltation of the streambed, particularly in the area below Centerville Powerhouse, would be highly detrimental to the spawning success of spring-run king salmon.

5) Mitigation for 100 acres of meadow habitat would be needed. The area should be acquired, developed, and managed for wildlife.

6) Canals should be designed to protect wildlife. The design should be submitted to the Department of Fish and Game for approval.

Means of enhancing fishery resources in Butte Creek with the Jonesville project are listed below:

1) Reductions in water temperatures, increases in summer and fall flows, and improvements of screen and ladder facilities are

among the ways by which the anadromous fishes in Butte Creek can be increased. Another important feature might be channel improvements in the king salmon spawning area.

2) Jonesville Reservoir would be expected to produce a good trout fishery for rainbow and brown trout. The reservoir could be expected to support about 15,000 angler-days annually.

3) A limited amount of trout enhancement might accrue to larger summer releases of cold water in Butte Creek. The amount of any such increase was not determined.

The Wing Project

The following recommendations are prescribed to protect fish and wildlife:

1) Fish passage and screening facilities should be constructed at the Paynes Creek Diversion Dam.

2) A fish transportation of 30 cfs or the natural flow should be released below the Paynes Creek Diversion Dam from October through May.

3) Further study would be required to determine the need for facilities and flows at a possible Battle Creek Diversion.

4) Any canal should be designed to protect wildlife and the design should be approved by the Department of Fish and Game.

Fish and wildlife resources could be materially enhanced by:

1) Construction of Wing Reservoir and provisions for stable reservoir operations. The resultant fishery could support 70,000 angler-days.

2) A minimum pool of 5,000 acre-feet, excluding silt storage, should be retained to support fish during years when drawdown occur.

3) The project sponsor should initially stock Wing Reservoir with warmwater gamefish at a cost of $18,750 and restock the reservoir after severe drawsowns to less than 25,000 acre-feet.

4) Selective retention of vegetation within the reservoir site should be permitted to increase the yield to the fishery.

5) Stable reservoir operation would provide about 690,000 waterfowl days use annually.

The Belle Mill Project

The following requirements should be met to preserve the fishery resources of the area:

1) Fish screens and fish passage facilities should be provided at the proposed diversion dam on Antelope Creek.

2) The following downstream releases should be made below the proposed diversion dam to preserve the salmon and steelhead resources of Antelope Creek:

Jan. 1 - May 31:	75 cfs or the natural flow, whichever is less.
June 1 to Sept. 30:	50 cfs or the natural flow, whichever is less.
Oct. 1 to Dec. 31:	100 cfs or the natural flow, whichever is less.

The fishery resources of the area could be enhanced by:

1) A minimum pool of not less than 2,000 acre-feet should be provided in Belle Mill Reservoir.

2) The project sponsor should stock the reservoir initially with warmwater gamefish at a cost of $5,750.

3) Further studies should be conducted to determine the desirability and cost of a roughfish eradication program on Antelope Creek above the diversion dam.

4) A plan for the selective retention of vegetation and/or provisions for the addition of brush shelters should be prepared and carried out to optimize returns to the fishery.

5) The possible removal of the Coneland Water Company Dam and the subsequent relocation of ditches emanating from the dam should

be considered. Such a plan would provide more spawning area for fall-run salmon and present spring-run salmon and steelhead with fewer migration difficulties.

6) The entire flow of Antelope Creek below the proposed diversion dam should be restricted to one channel to avoid the stranding of migratory salmonids.

7) Possibilities for constructing an artificial spawning channel should receive further study.

The Butte Basin Project

Phase 2 will create some problems for fish. The following recommendations are suggested:

1) The Chico Landing Weir should be provided with a suitable fishway at each end.

2) The weir stilling basin should be designed to permit fish to move from one end to the other when there is no overflow.

3) Borrow areas along the training levees between Ord Ferry Road and Chico Landing Weir should have continuous channels connected with the stilling basin and leading to the fishway entrances.

4) The need for fish barriers to prohibit fish from entering Little Chico Creek and Edgar Slough should be investigated.

From a wildlife standpoint, the best thing that could happen to the Butte Basin would be to continue with present land and water use. The following recommendations are prescribed to protect wildlife from impending changes caused by implementation of Phase 3.

1) The developing agency should purchase all lands and levees within the bypass area.

2) These lands should be dedicated to wildlife habitat and should be managed by the Department of Fish and Game at project cost.

3) Some lands which are now in agriculture should be leased back to agricultural interests on a short term basis. This will permit change to more intensive management for wildlife if necessary.

Leases should provide for agricultural use most advantages to wildlife and limit detrimental practices. Public access for hunting and fishing should be assured.

4) Provisions should be made to provide raised islands within the bypass at intervals sufficient to provide emergency cover for wildlife during times of flooding in the bypass. Tree and brush cover should be permitted to grow on these islands. The bypass should be sized to provide for these islands and riparian vegetation.

5) Provisions should be made to develop and maintain borrow ditches next to both levees. These should be connected to existing channels. Water from the Sacramento River should be provided to maintain a constant water movement in these ditches, plus some water for crops and seasonal flooding.

With Phase 3, some fish and wildlife enhancement could be realized. Fishery enhancement for warmwater gamefish could be provided in the levee borrow pits. The bypass could provide additional hunter-use. Additional study would be required to assess the magnitude of any such enhancement.

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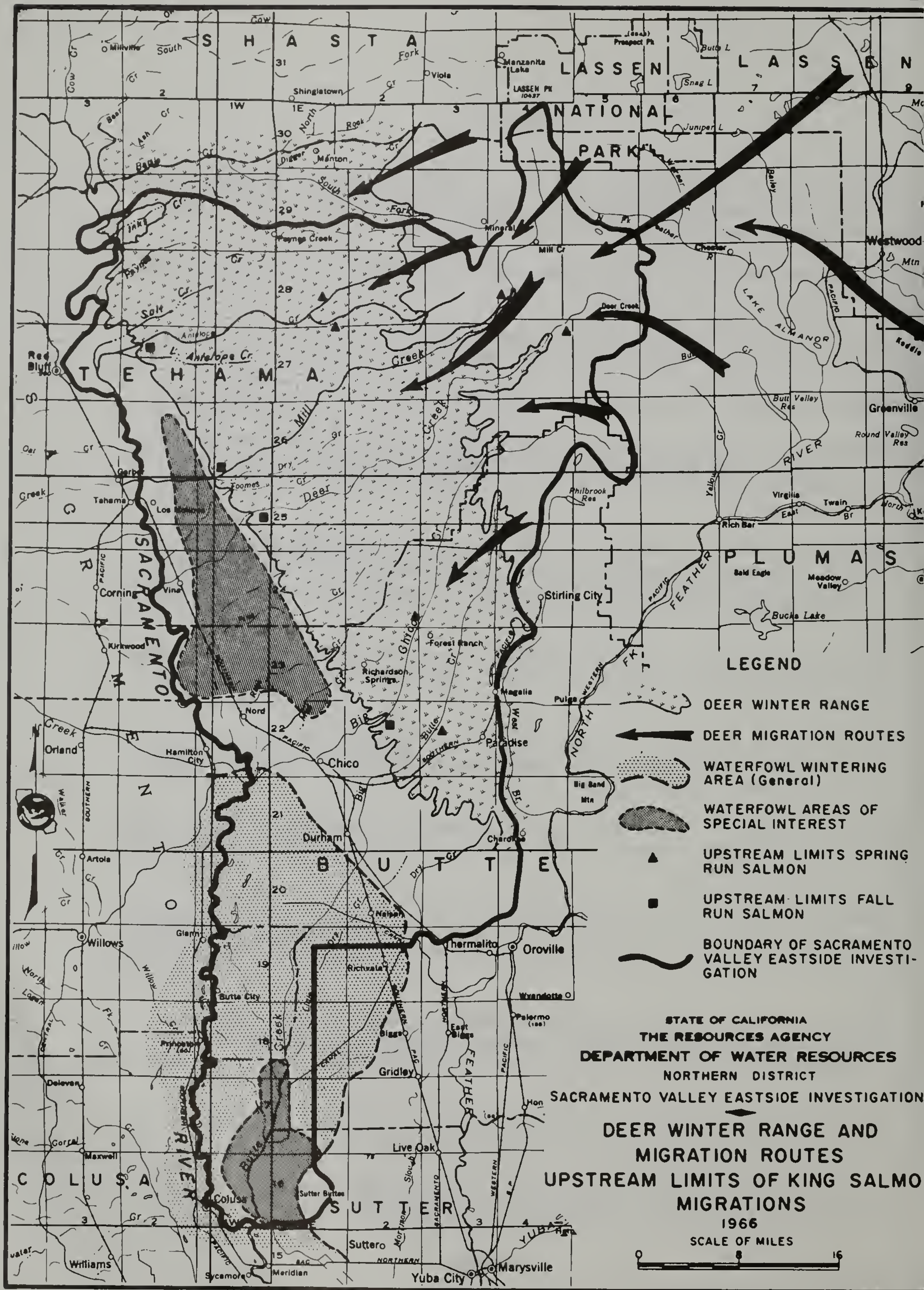
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Mill Creek
Deer Creek
Butte Creek
Big Chico Cr
Paynes Creek
Battle Cr
Cow Cr
Bear Cr
Salt Cr
Toomes Cr
Thomes Creek
Stony Creek
Dry Cr
LEGEND
DEER WINTER RANGE
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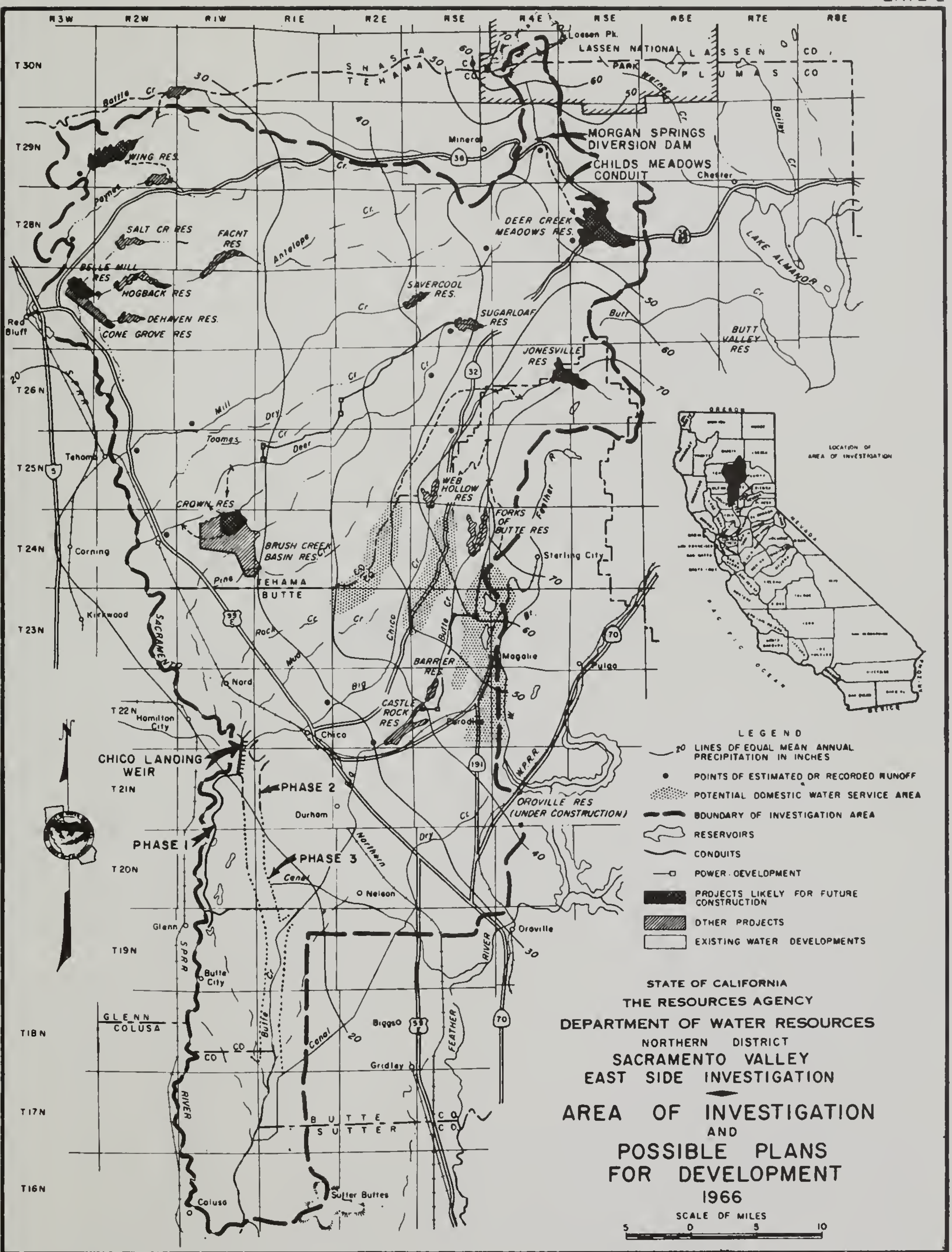

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THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
SACRAMENTO VALLEY
EAST SIDE INVESTIGATION

AREA OF INVESTIGATION AND POSSIBLE PLANS FOR DEVELOPMENT

1966

Appendix D

ACKNOWLEDGMENT

APPENDIX D. ACKNOWLEDGMENT

Many organizations and private individuals contributed valuable assistance to the Sacramento Valley East Side Investigation. Major contributions were made in the form of data, ideas, and access to private property. Cooperation received from the following organizations and individuals is gratefully acknowledged.

Bureau of Reclamation, United States Department of the Interior
Corps of Engineers, United States Army
Fish and Wildlife Service, United States Department of the Interior
Forest Service, United States Department of Agriculture
Geological Survey, United States Department of the Interior
Soil Conservation Service, United States Department of Agriculture
California State Department of Fish and Game
California State Department of Parks and Recreation
Butte County Department of Public Works
Shasta County Department of Water Resources
Tehama County Flood Control and Water Conservation District
City of Chico
City of Red Bluff
Paradise Irrigation District
Los Molinos Mutual Water Company
Stanford-Vina Ranch Irrigation Company
Deer Creek Irrigation District
Collins Pine Company
Pacific Gas and Electric Company
Mr. R. C. Anderson
Mr. W. Clough
Mr. C. L. Cobb
Mr. E. Foor
Mr. W. H. Hampton
Mr. W. S. Keeler
Mr. E. V. Wing

STATE OF CALIFORNIA
The Resources Agency
Department of Water Resources

BULLETIN NO. 137

SACRAMENTO VALLEY EAST SIDE INVESTIGATION

A Summary of the Public Hearing Comments and Changes to the Preliminary Edition Dated August 1967

Final Supplement

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FEBRUARY 1969

NORMAN B. LIVERMORE, JR.
Secretary for Resources
The Resources Agency

RONALD REAGAN
Governor
State of California

WILLIAM R. GIANELLI
Director
Department of Water Resources

FOREWORD

This supplement finalizes the preliminary edition of Bulletin No. 137, "Sacramento Valley East Side Investigation". It presents (1) a summary of the public hearing comments received on the bulletin, (2) the response of the Department of Water Resources to those comments, (3) an errata sheet for the preliminary edition of Bulletin No. 137, and (4) a statement by the California Water Commission.

Bulletin No. 137 presents the results of a 5-year water resources study of the streams tributary to the Sacramento River from the east, between Battle Creek and the Sutter Buttes. The bulletin, which is briefly summarized in the introduction to this supplement, outlines the objectives, activities, and conclusions of the investigation and describes the plans which have been formulated.

Public hearing comments on the bulletin were primarily concerned with the need for more flood control storage capacity in the various proposed reservoirs.

The public hearing on this investigation was held in Chico on December 7, 1967. Transcripts of this hearing are on file with the California Water Commission in Sacramento and the Northern District of the Department of Water Resources in Red Bluff and are available for review by the public.

William R. Gianelli

William R. Gianelli, Director
Department of Water Resources
The Resources Agency
State of California
February 4, 1969

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

RONALD REAGAN, Governor
NORMAN B. LIVERMORE, JR., Secretary for Resources, The Resources Agency
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DEC 9 1968

Honorable W. R. Gianelli, Director
Department of Water Resources
1416 Ninth Street
Sacramento, California 95814

Dear Mr. Gianelli:

The Commission has reviewed your draft of Appendix E, "Public Hearing," which summarizes public testimony and the responses of the Department on the preliminary edition of Bulletin No. 137, "Sacramento Valley East Side Investigation."

As indicated by the descriptive subtitle of the report, it should be recognized that the work was a study of surface water development opportunities. The projects which were identified and studied will require more in-depth study before local decisions can be made to undertake any of them. Within the limits of time and funds, the engineering feasibility and the economic justification, that is, comparison of benefits and costs, have been evaluated. The final and all-important test of a project proposal is financial feasibility. Can funds be obtained to construct, operate and maintain the project and can the reimbursable costs be repaid? Local water leaders and entities should evaluate each of the potential projects with these considerations in mind.

It appears that the areas most in need of supplemental water are the Cohasset, Forest Range and Eden areas northeast of Chico and the adjacent Paradise Irrigation District. Although the testimony indicated some disagreement regarding the time when water will be needed, it is apparent that future growth will be dependent on more water. The multipurpose Jonesville Project, which could provide adequate supplies to meet the growth for about 40 years, as well as provide recreation, fishery enhancement and flood control benefits, holds promise as a desirable project for these areas. It will, however, be necessary to form some type of agency to represent these geographically separate service areas to arrange for the planning, financing and construction of facilities and to repay reimbursable costs.

The Commission concurs with the recommendation of the Department that an appropriate agency be formed to pursue the Jonesville Project. There appears to be adequate information on which to base plans for formation of a legal entity. Local leaders should recognize that several years are usually required for an organized area to bring a project into reality. It is prudent to begin organizing now, even though water needs may be as far off as ten years.

Sincerely yours,

Ira J. Chrisman

Ira J. Chrisman
Chairman

INTRODUCTION

The California Water Commission and the Department of Water Resources jointly held a public hearing on the preliminary edition of Bulletin No. 137 in Chico on December 7, 1967.

Gordon W. Dukleth, District Engineer of the Northern District, was the hearing officer for the joint hearing, which was held in accordance with the Water Resources Act of 1945 set forth in the California Water Code under Sections 12616 to 12622 inclusive and Section 12626. Representing the California Water Commission were Clair A. Hill and Edwin Koster, Members; William M. Carah, Executive Secretary; and William L. Berry, Sr., Engineer.

Although public hearing testimony emphasized the need for additional flood control storage in the proposed East Side projects, Department studies show that more flood control provisions are just not economically justified at this time. This finding is confirmed by Bulletin No. 150-1, the report on the Department's 2-year extension of the Upper Sacramento River Basin Investigation which was concluded in June 1968. The results of this study show that: (1) Even with the construction of all of the projects currently under consideration, it is not possible to eliminate overflows from the Sacramento River near Chico Landing; (2) it will be many years before all of these projects are justified and constructed; and (3) the best solution to flood problems in the Upper Sacramento River Basin is an integrated plan utilizing reservoir storage, levees, and flood bypasses, and floodplain management. Bulletin No. 150-1, scheduled for publication in February 1969, shows that the projects presented in Bulletin No. 137, under current conditions, are the best developments for the Sacramento Valley East Side area.

The testimony received at the public hearing should be carefully reviewed by local, state, or federal agencies that undertake feasibility studies on any of the projects described in the bulletin, or studies on any other water development project in the area. Feasibility studies on any of the proposed projects should include a detailed analysis of the inclusion of maximum flood control reservations, for both local and downstream flood benefits.

SUMMARY OF BULLETIN No. 137, "SACRAMENTO VALLEY EAST SIDE INVESTIGATION"

(This section is a reprint of the conclusions and recommendations contained in the preliminary edition of Bulletin No. 137.)

The Sacramento Valley East Side Investigation study area is rich in natural resources, including water, timber, irrigable lands, and fish and wildlife. The orderly and timely development of these resources is essential to the future economic growth and expansion of this area.

More than 98 percent of the east side area's present water requirement, about 1 million acre-feet per year, is used for agricultural purposes. This water comes from ground water and surface diversions from the east side streams, and the Sacramento and Feather Rivers. Irrigation diversions on the valley floor take nearly all of the summer flows from the major east side tributaries.

There has been very little development of the water resources of the east side area. Runoff from the area, amounting to about 1.2 million acre-feet on a mean annual basis is almost completely uncontrolled since there are no existing reservoirs having more than a few thousand acre-feet of storage. The area needs water development projects to conserve this runoff and to allow residential development in prime mountainous plateau lands; supply additional irrigation water; provide enhancement flows for trout, salmon, and steelhead; and provide flood control.

There will be a large increase in water requirements in the east side area in the future; the present requirement of 1 million acre-feet per year will increase to about $1\frac{1}{4}$ million acre-feet by 2020. Only 48 percent of the gross irrigable lands in the area is presently irrigated. The 1960 population of 69,000 will increase to an estimated 370,000 by 2020.

The east side area's future water requirements will be supplied from a combination of sources. Ground water and major surface water developments (the State Water Project and the Central Valley Project) are capable of providing for the major future water requirements of the east side area at very favorable rates. Therefore, the local projects formulated during this investigation are designed primarily to solve the unique problems of the area that cannot best be met by these sources. These problems include: (1) the need for enhancement of recreation resources to satisfy the growing statewide demands for outdoor recreation opportunities; (2) the need for domestic water supplies in areas that are topographically beyond the reach of the major water supply sources; (3) the need for local flood protection; and (4) the need for preservation and enhancement of the valuable anadromous fishery populations of the area. Results of this investigation indicate that the following four multiple-purpose projects have a good potential for future construction.

1. Mill-Deer Project - centered about a proposed Deer Creek Meadows Reservoir on upper Deer Creek. Surplus water would be diverted to the reservoir from Mill Creek by means of the Morgan Springs Diversion Dam via the Childs Meadow Conduit. Water would be rediverted to terminal storage in Crown Reservoir on Brush Creek via the Ishi Diversion Dam and Yahi Canal. This multiple-purpose project would produce 20,000 acre-feet per year of new water for local irrigation and 18,000 acre-feet per year of new yield at the Sacramento-San Joaquin Delta. It would increase Deer Creek salmon and steelhead runs by about 18,000 fish per year, and would ultimately provide for about 1,500,000 visitor-days of fishing and other types of water-associated recreation use per year. If constructed in 1970, this project would have a capital cost of $30,400,000 and a benefit-cost ratio of 1.20:1.

2. Wing Project - consisting of a dam and reservoir on Inks Creek, a diversion dam and conduit to deliver surplus water from Paynes Creek to the Inks Creek drainage, and water-associated recreation facilities. The project would be operated for recreation and yield to the Sacramento-San Joaquin Delta. The project would have a gross storage capacity of 244,000 acre-feet, an annual yield of 28,000 acre-feet, and a capital cost of $9,910,000. If constructed in 1970 it would have a benefit-cost ratio of 1.16:1.

3. Jonesville Project - consisting of a dam and reservoir on upper Butte Creek and a series of gravity diversion dams and conduits to deliver domestic water supplies to the Cohasset, Forest Ranch, and Magalia-Paradise Ridges. The project would also provide water-associated recreation opportunities. The reservoir would have a gross storage capacity of 46,000 acre-feet and an annual yield of 25,000 acre-feet. This project would have a capital cost of $11,490,000. Although this project is not presently economically justified, the growing demands for water and recreation opportunities will enable this project to show economic justification by about 1975.

4. Belle Mill Project - consisting of a dam and reservoir on Salt, Little Salt, and Millrace Creeks; a flood diversion system from Antelope Creek; downstream channel improvements on Salt and Millrace Creeks; and water-associated recreation facilities. This project would be operated for flood control and recreation. This project would have a capital cost of $11,500,000. Although this project is not presently economically justified, the rapidly increasing population and property values in the floodplain and the ever-increasing demands for water-associated recreation will probably enable this project to show economic justification by the year 2000.

It was recommended in Bulletin No. 137 that:

1. The Wing Project on Inks Creek and the Mill-Deer Project on Mill and Deer Creeks, comprising the best initial development of these waters, be considered by local, state, and federal agencies contemplating future developments to meet local needs and/or export demands on the Sacramento-San Joaquin Delta.

2. Butte County initiate the formation of an appropriate county-wide or local water district to study the Jonesville Project on Butte Creek. And that this district, once formed, explore the possibility of early construction of the Jonesville Project to provide domestic water supplies to the Paradise-Magalia, Cohasset, and Forest Ranch areas. In the event that the project size shown herein exceeds that proposed by the district, participation by the State under Section 12880 (f) of the Davis-Grunsky Act be considered to insure services to the entire area.

3. The U. S. Army Corps of Engineers continue investigation of a solution to flood problems on Antelope Creek in Tehama County utilizing storage and channelization works as proposed in the Belle Mill Project, or a justifiable alternative thereto suitable to local interests and the Department, and seek authorization for construction at the earliest possible date.

SUMMARY OF COMMENTS AND DEPARTMENT RESPONSE

All comments received on the bulletin are presented in this section. Some of the comments are verbatim, others have been edited to eliminate details not vital to the main comment. The original copies of all comments are on file and available for public review in the Northern District office in Red Bluff.

1. U. S. Army Corps of Engineers

"As you know, the Corps of Engineers has been studying the area covered in Bulletin 137, under two broad investigations authorized by Congress: The Northern California Streams investigation, which includes the entire Sacramento River Basin as well as the coastal basins north of San Francisco; and the Sacramento River and Butte Basin investigation, which includes a large part of the Sacramento River Basin. Also, a restudy of the Antelope Creek unit of the authorized Sacramento River Major and Minor Tributaries project is underway. This unit of the authorized project was deferred for restudy due to the lack of necessary local cooperation.

"In general, except for the Belle Mill Project, it appears that your studies are based on providing flood control in an incidental manner only, by storing floodwaters in whatever empty conservation space may be available. We believe that dependability is one of the most important aspects of flood control operation and therefore we feel that if flood control is to be a project function, space reservations and reservoir operation should be provided specifically for flood control. We would not allocate any cost to flood control for reservoirs not providing dependable regulation of floodflows. We also feel that in addition to meeting the local flood control requirements, each major tributary of the Sacramento River below Shasta Reservoir should include enough flood control space, if economically feasible, for that tributary to control floodflows so as to meet the Sacramento River Flood Control Project design flow of 160,000 cfs upstream of Moulton Weir, insofar as possible.

"The Belle Mill storage plan presented in the report appears to offer promise for solving the flood problems of Antelope Creek. Your report indicates that the project would not be economically feasible on the basis of present information. According to our studies to date, considerably more flood space in the reservoir than was used in your analysis may be required for proper control of downstream flows in the Sacramento River system. Such additional storage would also act to reduce or eliminate the costs of downstream channel improvement on Antelope Creek, and would add flood control benefits. These added benefits, together with possible inclusion of other purposes as noted in your report, might improve the indicated economic feasibility of the project. As recommended in your report, the Corps of Engineers will continue its investigations on Antelope Creek in an attempt to find an acceptable, economical solution to the Antelope Creek water resources problems.

"The Deer Creek Meadows Reservoir (with diversion from Mill Creek) controls only about 25 percent of the drainage area of Deer and Mill Creeks. However, due to a lack of suitable downstream storage sites, this reservoir and diversion, together with downstream diversions, may be the best plan for developing the water resources of the basins, provided that specific flood control space reservation and reservoir operation criteria are incorporated into the proposed plan.

"As presented in your report, the Wing Reservoir appears to be the best storage site in the Battle, Paynes, and Inks Creek area and further studies should include diversion of the floodflows of Battle and Paynes Creek to this site.

"The Jonesville Project on Butte Creek appears to be designed for service to a local area, and controls only a small portion of the drainage area. To meet the flood control and conservation requirements of Butte Basin, downstream Sacramento River and the Sacramento-San Joaquin Delta, it appears that it may be desirable to construct storage farther downstream, possibly at the Covered Bridge site located in Sections 25 and 26, T22N, R2E, either as an alternative to the Jonesville site or as a supplement thereto."

Department Response: The Department, although it found no economic justification for including flood control storage in Deer Creek Meadows, Wing, or Jonesville Reservoirs, supports the Corps in their efforts to do so, in either these reservoirs or alternative ones.

2. California State Department of Conservation, Division of Forestry

"Construction of reservoirs by sponsoring local organizations will have an important and direct effect on programs and responsibilities of the Department of Conservation. We are particularly concerned about the impact of projects on wildland fire protection -- the responsibility of this Department's Division of Forestry. The proposed projects will require a major revision of fire protection needs in the area because of (1) the need for fire protection measures during project construction to minimize increased fire risk imposed by the activity of the contractors' men and equipment, (2) the need for improvements that should be installed during project construction that will minimize the fire problem during project operation, (3) the need to replace or relocate Division of Forestry facilities as a result of the projects, (4) disruption of existing access roads and fire defense measures, and (5) the changes in values and land use following construction.

"Capabilities of the present Division fire protection system shall be given full consideration. Fire prevention and fire safety needs shall be given first priority in any study undertaken. The Department of Conservation will work with Federal, State and local agencies in planning and presenting plans in a manner consistent with cooperative work now being accomplished between this department, the Federal Government, other State departments and local sponsoring agencies. The sponsors of individual projects are requested to include resulting fire protection costs as a direct project cost."

Department Response: The Department recognizes the importance of fire protection during project construction and operation. This factor will be given detailed consideration if further studies are carried out on any of these projects.

3. California State Department of Fish and Game

"Our Department would like to congratulate the Department of Water Resources on their report, Sacramento Valley East Side Investigation. The water development plans presented represent a truly multiple-purpose approach to water development.

"Some of the potential projects identified would provide significant fish and wildlife benefits. Measures to protect existing fisheries have received adequate consideration and are included in the project plans which have been formulated.

"The planning effort leading to the publication of Bulletin No. 137 has been an outstanding demonstration of what can be accomplished when our Departments work together to develop mutually satisfactory solutions to the complex resource management problems associated with water development. The Department of Fish and Game stands ready to work with any agency proposing to develop the projects identified in the bulletin."

4. California State Department of Parks and Recreation

"We believe your evaluation of these projects is reasonable, but it should be noted that the visitor-day value is based on the Trice-Wood method, no longer in use by our Departments. Evaluation of these projects by the "Guidelines for Evaluation of General Recreation" would result in somewhat different values, based on the particular recreational attributes of each reservoir, rather than its location.

"The recreation facility costs used in the report were applicable at the time the recreation appendix was prepared. However, based on recent experience with recreation facility development, the unit cost estimates for camp and picnic facilities have risen significantly.

"Both the benefit and cost estimates should be refined when feasibility studies are conducted on any of the projects discussed in this report."

Department Response: Methods and criteria for determining benefits and costs of water projects are in a continual state of fluctuation and revision. Recreational analyses are no exception. As the statement mentioned, the benefits and costs used were those applicable at the time the recreation analysis was made. If further studies are conducted on any of these projects, the recreation benefits and costs should be updated.

5. <u>California State Department of Public Works -- Division of Highways</u>

"From our review of Bulletin No. 137, we noted that within your Sacramento Valley East Side Area of Investigation, portions of State highway Routes 99, 32, 36, 172, and 89 are located.

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"It appears that your tentative downstream channel improvements on Salt Creek may affect existing Route 99 where it crosses east of Red Bluff.

"It also appears that your Childs Meadow conduit and Deer Creek Meadows Reservoir will affect portions of our Routes 36, 89 and 32. Currently, Routes 36 and 172 are being studied for improvements to expressway standards between Mineral and Morgan. Route 32 apparently will be affected at the conduit crossing below the Jonesville Reservoir.

"As construction on any of your water projects becomes more imminent, we will appreciate any further information you can furnish, particularly, as they affect any of our State highway routes in the area."

<u>Department Response</u>: The Department of Water Resources will keep the Division of Highways informed of all future studies that the Department undertakes in the east side area.

6. <u>The Reclamation Board</u>

"Of the four multiple-purpose projects mentioned for possible future construction, it appears that only the Belle Mill Project would be specifically operated for flood control. If this is the case, all potential flood control accomplishments would be incidental to other uses and therefore there would be no real or assured flood control in other than the Belle Mill Project. Because of this it appears that the unit evaluation of fifty cents per acre-foot of active reservoir storage may produce liberal (larger than probable) average annual primary flood control benefits.

"The proposed Mill-Deer Project does not include features specifically for flood control and it is doubtful that they would be economically feasible. The evaluated benefits may be liberal because there are no substantial flood damages on Mill and Deer Creeks and the accomplishments would be small. During detailed studies, however, consideration might be given to constructing the reservoir spillway to provide as much flood control as possible during extremely large floods by means of spillway surcharge storage.

"In consideration of the Wing Project, it appears that although there are no substantial flood damages on Battle Creek and it is not a significant contributor to flood flows of the Sacramento River, the enlargement of Wing Reservoir to accommodate Battle Creek flood flows should be seriously considered. Due to the favorable topography at the reservoir site, spillway surcharge alone might materially reduce flood flows of Battle Creek.

"The Jonesville Reservoir would provide no significant flood control and would not materially reduce flows of the Sacramento River. Benefits would not exceed the evaluated amounts.

"The Belle Mill site is the site selected by the Corps of Engineers for the authorized flood detention basin. The Corps flood control basin differs from the Belle Mill Reservoir in two main features:

1. After reduction by storage in the basin, it would divert flood flows northwesterly to the Sacramento River.

2. The required storage space would be smaller.

"The Corps is authorized and probably prepared to construct the flood basin provided local approval of the project can be secured. The Belle Mill Reservoir is determined not to be feasible at this time; therefore, consideration might be given to step development of the Belle Mill Project. The first step could be fulfillment of the Corps authorized project in a manner that the reservoir can be enlarged in the future to provide the storage capacity desirable for conservation when it is feasible.

"It appears that using $1.00 per acre-foot of active storage gives average annual remote flood control benefits in the right order of magnitude for this project. However, the value of $112,000 per year for local flood control benefits might be somewhat low.

"Nowhere in Bulletin No. 137 is mention made of the total effect the proposed projects would have on the flood flows in the downstream reaches of the Sacramento River. It is felt that this is an important consideration and should be incorporated into the report.

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"On page 269, the fish and wildlife report in discussing the Belle Mill Project states, "Flood control afforded by this project would have adverse effects on wildlife in downstream areas." It is hard to conceive of any possible losses unless they are meant to be in Lower Butte Basin where floods cause lands to remain in a nearly natural state. Antelope Creek is not a large tributary to overflow in Butte Basin and any appreciable reduction of overflow would occur during the large river floods when there is already too much water in the basin. There would be negligible detrimental effect to wildlife.

"On page 274, under "Probable Effects of Project upon Fish", it is said that "Frequency of spills into Butte Basin would change slightly." On page 278, it states that probable flooding frequency would change from once a year to twice in five years, which is more than a slight amount. Also it is indicated that the Chico Landing Weir would have a stilling basin. The authorized plans call for a ground level control structure such as Colusa Weir. Also, no borrow pits adjacent to levees were contemplated as they would be conducive to levee wave wash."

Department Response: Recent studies by the Department for Bulletin No. 150-1, "Upper Sacramento River Basin Investigation", have shown that, under current conditions, a diversion of Battle Creek water to Wing Reservoir is expensive and in excess of the benefits. However, as the need for new water supplies increases, this diversion plan should be considered further.

Bulletin No. 150-1 discusses the possibility of adding flood control storage at the Deer Creek Meadows Reservoir and the benefits of providing such storage.

The effects of many possible future projects on peak floodflows in the Sacramento River will be discussed in detail in Bulletin No. 150-1.

7. Butte County

"We were generally encouraged with the feasibility status that the Department attached to the Jonesville Project on Butte Creek, but were somewhat disappointed, of course, in finding that the study indicated that this was the only project in Butte County, within the study area, which was considered close to being economically justified, and then not until approximately 1975. In this light, therefore, we would briefly offer the following suggestions:

"Number of projects considered. There exist potential projects and combinations of projects within Butte County and within the study area which, it appears, were not analyzed in this study. These projects are outlined in State Bulletin No. 3 entitled The California Water Plan and other publications and are primarily located on Big Chico Creek and Butte Creek. Although it is realized that the feasibility of some of these projects has been impaired because of the existing levee-type flood control projects downstream, it is felt that a general analysis of these projects should have been made. As a further suggestion in this regard, it would be helpful and informative to a local area, in which a number of projects are reviewed, to have the determined benefit-cost ratios shown in the report for all of the projects analyzed, in order that a generalized development pattern might be established.

"Flood control benefits assigned to projects. We would question the arbitrary value of fifty cents per acre foot of active storage which was used in the report as a realistic figure for the flood control benefits of the east side reservoirs. The basis for this value appeared vague. We would suggest that greater emphasis be placed on determining this benefit, which is of utmost importance to the northern counties, and that downstream effects in the Sacramento River, including benefits related to seepage and bank erosion be considered. We would hope that such a comprehensive analysis of the flood control benefits would indicate a higher value than that used, resulting in a more favorable overall benefit-cost ratio on some of the projects considered.

"Water supply benefits. The report appeared to somewhat minimize the importance of the east side projects as a future water supply for the east side by the following statement: 'An analysis of future water requirements and potential sources of water supply indicates that ground water plus the State Water Project and the Central Valley Project are capable of providing for the major future water requirements of the east side area at very favorable rates.' From a physical standpoint the potential service area of the State Water Project includes only a very small area of the east side study area. Even under a Feather River-Sacramento River exchange concept we would question the alternatives suggested to supply the major future water requirements of the east side, primarily because of elevation limitations of these alternatives.

"In conclusion, therefore, we again wish to commend the various departments on the detail given the projects under study. The items mentioned above are offered as possible constructive suggestions only, rather than an attempt to de-emphasize the value of the study. We feel that the report will be very useful to us and the transition from reconnaissance to feasibility-type studies can now progress in a logical and normal sequence. We are looking forward to working with the various local, State and Federal agencies in developing the Jonesville Project or any other project which might prove feasible at a later date."

Department Response: It is not possible to present detailed analyses of all projects which were considered during the investigation. As these studies progressed, projects which were obviously inferior to others and apparently not economically justified were deleted from detailed formulation studies. Considerably more time and money would be necessary if benefit-cost ratios were prepared on a comparable basis for every project studied.

The 50 cents per acre-foot value for flood control benefits was determined in the Bulletin No. 150 studies completed in 1964. This value was found to be applicable for the reconnaissance evaluation of projects on Cottonwood and Cow Creeks. A detailed analysis of flood control benefits for the east side tributaries would probably not yield benefits significantly greater than 50 cents per acre-foot of storage.

8. Shasta County

"Our comments may be summarized as follows:

"1. The Battle Creek drainage, comprising over 360 square miles of drainage area, should be included in any studies undertaken in this general area.

"2. Flood control should be given greater consideration, as recommended in the Department of Water Resources Bulletin No. 159-65.

"3. The fish enhancement potential of the Battle Creek area should be thoroughly investigated.

"4. The Upper Sacramento River Basin Investigation currently under way by the Department should be expanded to cover the Battle Creek drainage with particular emphasis on the above points."

Department Response: Preliminary studies for Bulletins No. 150 and No. 137 have shown the Battle Creek diversion to Wing Reservoir to be expensive and unjustified. The current "Upper Sacramento River Basin Investigation", Bulletin No. 150-1, also shows this diversion to be economically unjustified under current conditions. However, as the demand for additional water supplies increases, this addition to the Wing Project should be considered further.

9. County of Tehama

"Antelope Creek causes considerable flooding troubles almost every year and as development increases each year so do the problems.

"We feel at this point that sufficient time and study was not given to the upstream storage potentials, such as Hogback and Facht sites and in a combination with a possible domestic outlet benefit in the Antelope area, plus a just flood control and recreation benefit ratio. This could be a feasible project at this time.

"The Belle Mill, as the Department is probably aware of, is at this time not what could be classified as a popular project and therefore the other alternatives should be explored further."

Department Response: Since the Corps of Engineers has an authorized levee project for Antelope Creek, this investigation sought to find an economically justified reservoir project which could solve the area's flood problems. A considerable amount of time was spent evaluating the Hogback and Facht sites, as well as the Belle Mill site. Even though the Belle Mill Project was found to be infeasible, it was still a better possibility than the other alternatives. The Corps of Engineers agrees and is proceeding with studies along these lines.

10. Northern California County Supervisors Association

"As the report indicates, flooding is a problem in the entire valley area. We, therefore, are concerned over the fact that it was not possible to include more flood protection in the projects developed in the bulletin. We hope that this can be reviewed in your Upper Sacramento Basin Investigation, now under way.

"We note that a considerable percentage of the project benefits will accrue to fishery enhancement and recreation features, a most important aspect of water resources development. We are concerned, however, as to the availability of funds for these allocations. We would suggest that a study be made of funding of these benefits in order to develop a continuing and adequate method of funding these project purposes.

"We are also concerned over the fact that Battle Creek, a most important tributary, was not included in either this bulletin or Bulletin No. 150, published in 1965. This is a very serious omission, and this basin should be included in your current Upper Sacramento Basin Investigation.

"We would like to take this opportunity to express our support of the Jonesville Project as a very desirable addition to the water development of the Sacramento Valley."

Department Response: The Department's studies for Bulletin No. 150-1 included a review of the flood control possibilities on each east side tributary and substantiated the finding of Bulletin No. 137. Though flood control is highly desirable, the benefits must justify the costs. Because the east side tributaries are minor contributors to Sacramento River floodflows, the benefits to downstream areas are small.

A statement concerning Battle Creek appears in the Department's response to comment number 8.

11. Paradise Irrigation District

"The Paradise Irrigation District is very much interested in the Jonesville Project.

"In 1966 a bond issue for a new dam below the present Magalia Dam was defeated by the voters of Paradise. This would have made available additional storage which the Directors of the District feel will be required within the next five years.

"Looking to the future, new distribution mains and storage reservoirs have been installed this past summer. This was from a $1,775,000 bond issue.

"Continued growth and added demand for water requires greater storage capacity as our present supply is dependent on winter floodwaters. Presently the amount of storage capacity is insufficient to store enough safely to supply the demand. Over 90 percent of our water is used for domestic purposes.

"The present usable supply consists of 1000 acre-feet in the present Magalia Dam, plus 6200 acre-feet in Paradise Dam.

"At the end of the peak season in 1966, the amount of available water was at a dangerous level.

"We would like to know when the Jonesville Project can be started; how long it will take to complete in order to have water available; and what amount of water would be available to Paradise.

"The Paradise Irrigation District believes that arrangements for transportation of water from the Jonesville Reservoir could be made with the Pacific Gas and Electric Company through its facilities."

Department Response: Butte County could help implement the Jonesville Project by helping to initiate a county-wide or local water district to study the project. The indication that Jonesville is not economically justified until 1975 assumes that the Paradise Irrigation District will have enlarged their existing Magalia system. If Magalia is not enlarged, Jonesville probably would be justified at some earlier date.

Once the Jonesville Project is determined to be justified and some agency has agreed to build it, design and construction would take about 3 years.

As viewed by the Department, Jonesville would yield a total of 25,000 acre-feet of water per year for use in the Cohasset, Forest Ranch, and Magalia-Paradise Ridge areas. Of this 25,000 acre-feet, about 18,000 acre-feet would be available to Paradise.

Regardless of who undertakes construction of the Jonesville Project, the water users would be expected to repay all of the costs allocated to water supply.

12. Mr. John Bisher, Chairman of the Board of Directors, Paradise Irrigation District

"It is quite unfortunate that the Department has determined that the Jonesville Project is not economically feasible until 1975. We have a condition up there that is going to require water before 1975 in addition to what we have now.

"We have a total storage capacity of 7,200 acre-feet of water in both reservoirs (Magalia and Paradise). Last spring the total usable acre-feet of water was 2,610 acre-feet, so you can see what a close margin we have of using up all of our storage water.

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"For the last several years there has been quite a rapid growth in population and during the last four or five years we have been unable to furnish all the water that is required to the entire Paradise Irrigation District because of the inadequacy of the size of the distribution lines.

"Now, we had a bond issue last year and we asked the voters to approve a bond issue for the construction of a new dam to impound about 8,000 or 10,000 acre-feet of water, additional water, and we also asked the voters to approve a bond issue of $1,775,000 for the additional distribution system. The voters approved the distribution system but defeated the bond issue for the dam. Now, we are in this particular predicament; we have the distribution system now which will be completely completed in about two weeks. That enables us to furnish water to the various areas of the district which otherwise couldn't have received water because we had to refuse water to several subdivisions in the last two or three years because we just didn't have any pipe lines to get water to them. Now, we have ample water lines but we are going to run out of water to put in them.

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"We have tried to get some water from Diamond National. Well, they don't have any. We have tried to get water from the Pacific Gas and Electric Company. We can only get a limited amount, and then it has to be transported through their own mains. Well, we intended to build a new dam below the Magalia Dam, about 1,000 feet down, to impound about 3,200 additional acre-feet of water, but there has been some suggestions that we raise the Paradise Dam. Well, that would give us considerably more water, but that takes a lot of money, and I was wondering, reading this Bulletin 137, I wasn't clear whether the development of these sources of water would be done by the Department of Water Resources or whether some of the local agencies would have to pay for it."

Department Response: See response to previous comment.

13. Mr. Roland H. Wight

"I am writing as a private citizen, although I am a Director-Elect to the Paradise Irrigation District to succeed on 12/29/67 Mr. John Bisher who made some comments this A. M. during the hearing.

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"I am naturally most interested in the Jonesville Project and its eventual benefit to our area, as well as the Cohasset and Forest Ranch areas.

"As a part of my recent election campaign, I prepared charts showing P.I.D. water consumption for the past 10 years, meter growth, water storage carryover each fall, and a final chart showing the increased debt service commitments due to the $1,775,000 dollar pipe line project just being completed under the engineering direction of Mr. Dean Kingman of Palo Alto, Calif. My theme was to take a hard look at any more improvements until our slackening growth pattern indicated a definite forward change. The people agreed nearly 2 to 1.

"Although political considerations have no place in a factual engineering study such as was offered to-day, the matter of determining our need for additional storage is of paramount importance. Private engineering firms have a service to sell and often exaggerate the degree of need. This District 4 years ago had this very experience via the Bechtel Corp., in my humble opinion, as the District Securities Commission

2 years ago found that any need for a new dam at that time was "premature". And since then there has been no radical upward change in water usage.

"In conclusion, I do not concur with Mr. Bisher's remarks nor his figures. I have been given a copy of Mr. Wm. R. Gianelli's letter of 11/2/67 to Mr. Wm. R. Barbier, recent Chairman of the Bd. of Directors of the Paradise Irrigation District until his resignation on 11/15/67. In the next to last paragraph, the alternative (a) of purchasing P. G. & E. water as an interim solution during an emergency, offers the cheapest solution until such time as our populace can stand any additional debt burden. We enjoy a very generous annual rainfall and our present reservoir capacity is more than sufficient to fulfill our foreseeable demands."

Department Response: Though it may be possible to defer the construction of additional storage reservoirs or importation of new water supplies for a few years, now is the time to be seeking out the possible solutions to future problems. Projections indicate that the District will need new water supplies in less than 10 years. It is important that over the years the total cost to the consumer be kept to a minimum. This can best be accomplished through early planning for future developments.

It is obvious that the total cost of a reservoir such as Jonesville could not be borne by the Paradise Irrigation District alone. The same is true for the Cohasset and Forest Ranch areas. It was for this reason that the Department concluded that Butte County should study this project under an appropriate county-wide district. This would insure services to the entire area.

The main interest of the Department of Water Resources in this matter is to lend assistance where needed to see that the waters of the State are put to the best and fullest use.

14. Butte Basin Protection Association

"We feel that:

"(1) The need for the construction of upstream storage facilities of a multipurpose nature is far in arrears, that such construction is immediately imperative - if we are to meet the population demands of the very near future.

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"(2) It is the opinion of the membership of the Butte Basin Protection Association that consideration and study be given to the enlargement of some of the projects recommended for development by relocating them further downstream in deep canyon areas as close as possible to the floor of the Sacramento Valley. Such relocation would serve to impound greater quantities of water by catching the runoffs from a greater area. Such lower relocation would also assist in recharging the underground water supplies drawn upon by pumps operating on the valley floor. The relocation of dams in deep canyons at lower elevations would also nullify the undesirable aspects of the flooding out and despoiling of present prime recreation areas as proposed in the Mill-Deer Project and the Jonesville Project. There is no justification for the destruction of beautiful mountain meadow-land; to contend that such meadow-lands must be sacrificed is a striking example of planning inflexibility. Blind adherence to such inflexibility is a desecration of Nature.

"(3) The No. 2 recommendation, as set forth on page 7 of Bulletin No. 137 (that Butte County form an appropriate local or county-wide water district to study the Jonesville Project), is not favorably considered for the reason that the action suggested therein is of a general nature and believed to be outside the purview of Butte County's responsibility. The possibility of a maintenance area, or of a service area, is also inherent in this recommendation. On the basis of past maintenance experience with Department of Water Resources, such possibility is not a palatable one to Butte County people.

"(4) Lastly, we wish to again reiterate our objections to the Butte Basin Project, particularly as it appears in Bulletin No. 137, Chapter 7, Page 273 (Appendix C, "Fish and Wildlife"). Time, people and progress have outmoded that project - which was first proposed to the Legislature in 1880 - 87 years ago - by the then State Engineer, William H. Hall."

<u>Department Response</u>: The Department is in agreement that for purposes of flood control it would be desirable to construct reservoirs on the east side of the valley just above the valley floor. However, suitable reservoir sites are just not available at reasonable costs.

Testimony at this hearing has clearly shown the necessity of future water supplies for the Paradise ridge area. Since the primary benefits for a project at this site would be for local water supply, it seems natural for a local agency to pursue this project.

15. <u>Collins Almanor Forest - Collins Pine Company</u>

"The proposed Mill-Deer Project reservoir at Deer Creek Meadows will flood meadow and timber lands owned to a large extent by Collins. In addition, nearly all of the lands surrounding this reservoir are also owned by Collins.

"These Collins properties are part of a certified Western Pine Tree Farm dedicated to the growing of successive crops of trees. These forest lands supply a substantial part of the year around production of the Collins Pine Company sawmill and flakeboard plant at Chester, California.

"The owners of these properties are, therefore, directly concerned with the effect the proposed reservoir will have on the management of these forests and on the operations of the Collins Pine Company.

"Apparently, at least 3100 acres will be required for reservoir and recreation development at Deer Creek Meadows. Additional acreage will be required for highway and logging road relocation. Another area of 680 acres will be required for game management needs.

"It is certain that this project will create additional demands for the relinquishment of private timber lands in the area and possibly for some curtailment of forest production activities.

"Study of the Mill-Deer Project benefit-cost ratio raises certain questions:

1. Has a realistic evaluation of the losses in timber and grazing values been made?

2. Have not the mileages of highway and logging road relocation been underestimated?

3. Where are the 500 acres of State Lands?

4. What will be the disposition of Smith's property, Fire Mt. Lodge, and Deer Creek Lodge?

"In summary, have all the real losses to the local economy been given adequate consideration?

"It is the present opinion of the Collins ownership involved in the area of the Mill-Deer Project, that Bulletin No. 137 does not give adequate economic justification for changing what is now a successful industrial forest enterprise to what in essence would be a forest recreational development of uncertain effect on the local area."

Department Response:

1. Timber and grazing values were not estimated. However, the appraised fair market value of land, which the Department included as a project cost, reflects the economic productivity of the land.

2. The Department believes that it has made an adequate allowance for highway and logging road relocations. These evaluations would be refined if further studies are undertaken for this project.

3. There are no state lands in the project area. The Department mistakenly identified some federal land as state land.

4. Disposition of an individual piece of property cannot be determined at this time. The Fire Mt. Lodge and Deer Creek Lodge might not have to be acquired. This would depend on the final size selected for the reservoir in a feasibility study.

16. Mr. L. A. Kimball

"In regards the proposed Jonesville Project, I wonder if it is possible that the domestic water needs of the Paradise area could be served as well by increased diversion from the west branch of the north fork of the Feather River, or perhaps by expansion and multi-use development of existing water storage facilities of that branch at the Philbrook Reservoir or Snag Lake. It would seem that the initial capital costs of such development would be far less expensive than the proposal for a Jonesville Reservoir, and would constitute an exemplification of the partnership of private and public agencies to meet public needs.

"In my opinion, the development of the proposed Jonesville Reservoir, with its recreational facilities, would seriously threaten the existing wildlife now so abundant in the area. I understand that a great deal more study is required before decisions can be made, and that various public agencies will be required to do supplemental work to make the project possible. I respectfully request that you give full consideration to alternate plans before determining the necessity to proceed with the proposal for Jonesville."

Department Response: Diversion of flows from the Feather River could meet the domestic water demands of the Paradise area for a few years. It may also be possible to develop Philbrook and Snag Lake to serve additional water to the Paradise area. However, these reservoirs and the diversion of flows from the Feather River would serve only as a temporary source of future water supplies to the Paradise area. The long-term needs of the area could not be met from these sources. Jonesville Reservoir appears to be the best development to meet these demands. In addition to the Paradise Ridge area, Jonesville Reservoir could be utilized to meet the growing demands of the Forest Ranch and Cohasset areas.

17. Mr. H. Wilfried Barmann (State Reclamation Board member speaking as a private citizen)

"I would like to comment that I certainly am in concurrence with the observation that Mr. Spencer of our board conveyed to you gentlemen (see comment number 6). This is the unanimous feeling of the whole board, that there was not enough flood control provisions provided for in this bulletin on the Sacramento River.

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"Bulletin 137, as far as I am concerned, is inadequate because it lacks imagination to construct these dams in the place where they can impound this water so that we can restrict the flow of water at flood stage running down the Sacramento River to an amount of water that the levees will stand.

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"I must recommend that when this bulletin is brought back that it certainly include large dams that give us the necessary flood protection as well as the other uses of water, municipal, industrial, fish and game, recreation, and all of the many needs that upstream storage gives in benefits to the people of this State."

Department Response: The Department does not believe that it is economically feasible, within the foreseeable future, to construct enough reservoirs to completely control all flooding in the Sacramento Valley. The benefits accruing from such flood control would not justify the expenditures. Flood control must be economically justified before it can be included in a project, just as all other purposes must be. Projects built on the tributaries in the future will be justified by water supply, recreation, and fishery enhancement, as well as flood control. In many cases, it will be the demand for water supplies which will dictate the time that these projects will be built. At best, it will be many years before these projects will be built. The streams under consideration in Bulletin No. 137 produce only a very small portion of the floodflows in the Sacramento River.

18. Mr. Claude L. Willis

"I was a chairman of a joint committee to study feasible water supply of the Cohasset and Forest Ranch areas. We found our biggest problem was a matter of immediate financing. Water is of paramount importance to our land.

"Also I would like to add to that that the levee that the Army Engineers constructed on Butte Creek was detrimental to the area in which I live in this respect, that through the building of levees they endeavored to do what should have been done by the building of some of the dams that the Division of Water Resources have proposed for our area. A good example of failure of levees can be taken from the 1955 flooding of Yuba City. It would be noted, if anyone is familiar with the area, that we have a natural bypass of the Feather out through what is now the town of Biggs, and after the flood of 1928, a levee was built so that the water never would go out through there again. Unfortunately, so they thought, the dam was breached again in 1937. This time it was built back to where it did hold and the result was the disastrous flooding of Yuba City."

Department Response: The Department feels that the best solution to flood problems is a carefully integrated complex of reservoir projects, levee and bypass systems, channel maintenance, and floodplain management.

19. Mr. Tom Borneman

"What effects on the minimum pool of the Butte Creek Project do the Pacific Gas and Electric Company water rights have?

"Since domestic water is part of the reservoir planning, will this eliminate swimming and boating?"

Department Response: In the planning for the Jonesville Project it was assumed that all water needed to meet PG & E downstream rights would pass through the reservoir without being stored. Thus these rights do not affect the minimum pool at Jonesville; honoring any downstream right does of course mean that more total active storage is required than would be required if these rights were ignored.

In analyzing the project, the Department assumed that swimming and boating would be allowed at Jonesville Reservoir.

20. Mr. Irving C. Elliott

"What plans, if any, are considered for reserving water for use in the Butte Creek watershed, from Jonesville Dam?"

Department Response: More than half of the water supply developed by the Jonesville Project is planned for use in the Butte Creek watershed, in the Magalia-Paradise area. Also, in determining the releases to be made from Jonesville Reservoir, the Department gave consideration to the existing water rights in other parts of the Butte Creek watershed. No water would be placed in storage at Jonesville if it were needed to satisfy an existing downstream right. Surplus inflow to Butte Creek below the proposed diversions would be available for future development to meet growing needs in the lower watershed.

21. Mr. Stephen H. Matteson

"We are interested in preserving the natural beauty and the ecology of the area. Could not the water to be stored at the Deer Creek and Jonesville areas be stored at lower elevations -- in areas not outstanding in scenic value and where the ecology of the area will not be disturbed?"

Department Response: These upper sites were selected because they are topographically well suited for the construction of dams and storage of water. No really good storage sites exist at the lower elevations on either Deer or Butte Creeks.

Outstanding scenery is the major reason that water-associated recreation developments would be most attractive in those areas. Recreation is a substantial benefit of these projects.

The ecology of any area unfortunately will be disturbed where man constructs a reservoir.

22. Mr. John W. Field

"What consideration was given in this report to the report in Bulletin No. 3 in regard to Castle Rock Reservoir?"

Department Response: Castle Rock Reservoir was studied during this investigation as one of the alternative plans of development for Butte Creek. As envisioned in Bulletin No. 3, "The California Water Plan", published in 1957, floodwaters from Big Chico Creek would be diverted to Castle Rock Reservoir and away from the city of Chico. However, the Corps of Engineers flood control project, constructed in 1965, now diverts Big Chico Creek floodflows into Mud Creek and realizes many of the flood control benefits which would have accrued to Castle Rock Reservoir. As a result, the reservoir is a project that probably will not be economically justified for some time.

23. Mr. Clair A. Hill, Member of the California Water Commission

"It seems that the hearing on this bulletin has been an outstanding success in raising a good many unanswered questions. There is one point that I think the Department should comment on before the hearing is closed and that is the question that is raised about dams on Battle Creek, Antelope Creek, Mill Creek, Deer Creek, and Butte Creek down low enough to do some good as far as flood control storage is concerned, because certainly dams up at the headwaters don't do much good in that respect.

"I was very interested in Mr. Masson's (Collins Almanor Forest) comment number 1, "Has a realistic evaluation of the losses in timber and grazing values been made", and I was very sorry that he didn't expand on that because that is one of the things that has concerned me for many years as we go on building reservoirs in these mountain valleys for the overall benefit of the lower areas. But I think there is little doubt that if Mr. Masson's statement here is projected on the average annual equivalent benefits on the same basis that recreation, fish enhancement, and so forth is done, that the annual benefit would come out vastly different. In other words, if you take the growing of timber as a crop in that area and project that as an average annual benefit, I would be very interested to see what kind of result there would be, because when you look at this Mill-Deer Creek Project as shown in the bulletin, it shows a capitalized or average annual equivalent benefit for the irrigation yield or water yield of less than half a million dollars as against a total equivalent benefit of $2,250,000. When I see this kind of figures ... I'm not at all clear who is supposed to put up the capital costs for that kind of economics."

Department Response: As noted in the responses to several other comments, flood control storage at the lower elevations is not presently justified. Following is a brief summary of the Department's findings concerning flood control storage on Battle, Antelope, Mill, Deer, and Butte Creeks.

The most northerly stream in the study area is Battle Creek. Our studies show that the best development on this creek would be the diversion of excess flows to Wing Reservoir on Inks Creek. This, however, requires a high, expensive dam on Battle Creek. The benefits for this project were less than the costs.

The most promising project on Antelope Creek is the Belle Mill Project, which is basically a single-purpose flood control project on the valley floor with a minor amount of recreation benefits. This project has a benefit-cost ratio of only 0.52 to 1.

There are very few good reservoir sites in the Mill and Deer Creek Basins. None of the damsites in the lower part of the drainage areas can economically impound large amounts of water. The flood control benefits for projects on these creeks are small for two reasons: (1) in-basin damages are small because of relatively high channel capacities, and (2) these streams are situated in a location such that they are not substantial contributors to peak Sacramento River flows.

Corps of Engineers levee projects on Butte and Big Chico Creeks prevent flood damages to these basins. Hence, reservoir projects on these streams are not justified at the present time.

The inclusion of flood control as a project purpose in any water resources planning study is a matter of economics just as is the inclusion of any other function. In all of the projects or alternatives studied during this investigation, the benefits for providing flood control were less than the costs.

The Corps of Engineers is studying projects on many of these same streams at the present time. The Department fully supports their efforts in this area.

As for the timber and grazing land losses, the estimated fair market value of all lands and timber stands taken by the project is included in the project cost estimates. The fair market value reflects the average annual benefit that could be derived from the land.

This study is classified as a reconnaissance-level investigation. The repayment analysis of a project is taken up during feasibility-level studies. Hence, no attempt has been made to determine methods of financing the water supply, irrigation, flood control, recreation, or fishery enhancement functions of these projects.

WITNESSES

The following individuals and organizations made statements on the bulletin.

Oral Statements

Wilfried Barmann, Member, State Reclamation Board, Chico

Clair A. Hill, Member of the California Water Commission, Redding

Robert D. Montgomery, Manager of Region II, California State Department of Fish and Game, Sacramento

Lewis L. Reese, California Division of Forestry, Sacramento

George H. Spencer, State Reclamation Board, Sacramento

Arnold S. Rummelsburg, Director, Shasta County Department of Water Resources, Redding

George Stamm, Butte County Water Resources Engineer, Oroville

John Bisher, Chairman of the Board of Directors, Paradise Irrigation District, Paradise

Ernest E. Hatch, Co-Chairman, Butte Basin Protective Association, Gridley

John Masson, Forester, Collins Pine Company and Collins Almanor Forest, Chester

Claude L. Willis, Chico

John W. Field, Chico

Tom Borneman

Irving C. Elliott

Stephen H. Matteson

Written Statements

Department of the Army, Corps of Engineers, Sacramento District

California State Department of Fish and Game

California State Department of Parks and Recreation

California State Department of Public Works -- Division of Highways

The Reclamation Board

Butte County

Shasta County

Tehama County

Butte Basin Protection Association

Northern California County Supervisors Association

Paradise Irrigation District

Collins Almanor Forest - Collins Pine Company

L. A. Kimball, Walnut Creek

Dean S. Kingman, Palo Alto

Roland H. Wight, Paradise

ERRATA TO BULLETIN No. 137

The following changes finalize the preliminary edition of Bulletin No. 137, "Sacramento Valley East Side Investigation":

Page 17, under heading "Existing Water Resources Facilities": Include levee and channel improvements on Cherokee Canal and on Butte, Little Chico, and Lower Deer Creeks.

Page 50, under heading "Deer Creek Meadows Reservoir," second sentence: Delete "of which 500 acres are presently owned by the State." There are no state lands in the project area.

Page 110, second paragraph, item (3): should read "Federal financing as a unit of the Central Valley Project and in some cases under programs of the Corps of Engineers."

Page 116 (Appendix A: "Bibliography"), under first heading, "United States Army, Corps of Engineers": Add House Document No. 649, 78th Congress, 2nd Session, "Sacramento River, Collinsville to Shasta Dam". This document presented the flood control plans which were authorized for Antelope Creek and Butte Basin and plans for existing projects on Deer, Chico, Little Chico, Butte, and Cherokee Creeks for Congressional approval.